SLUDGE INVESTIGATION RESULTS

June 30, 1983

KAISER ALUMINUM & CHEMICAL CORPORATION

TACOMA WORKS

Reference: DOE Order No. DE 83-197

RFDW TA 83-2

EXECUTIVE SUMMARY

The Tacoma Works of Kaiser Aluminum & Chemical Corporation was issued Washington State Department of Ecology Compliance Order No. DE-83-197 on April 15, 1983, the subject of which was to investigate the nature and extent of scrubber wastes deposited on the plant site. This report presents the results of the required investigations.

The wastes resulted from wet scrubbing of off-gases from the reduction process. They contain alumina, reduction cell bath materials, carbon and condensed pitch volatiles. The presence of pitch volatiles, which include polynuclear aromatic hydrocarbons (PAH) required that this waste to be evaluated under Washington State environmental rules. The rules characterize waste containing more than 1% PAH as "extremely hazardous waste."

The wastes accumulated on the plant site as consequence of settling of solids from recycled scrubber water in an air control system which ceased operation in 1974. These solids were removed from the settling basin on two occasions during the use of the system and deposited on unused portions of the plant site. Photographs and plant records of amounts of waste solids generated were used to estimate the location and total volume of these materials. The physical and chemical survey conducted as a part of these investigations accounted for the amounts of wastes recorded in plant files. Within the error of the recorded measurments and those of the survey, it is estimated that on the order of 45,000-50,000 dry tons of scrubber solids are deposited on the site.

The scrubber solids were chemically assayed and found to contain in excess of 1% PAH. In addition, ditch sediments, tidal marsh sites, ground water and effluent water from the plant site were sampled and analyzed. The sediments and soils were found to contain less than 1% PAH; effluent water and ground water samples contained less than 10 ppb.

Scrubber solids were also subjected to a toxicity assay required by the complicance order. These tests indicated that the waste would be classified as "extremely hazardous" under the toxicity assay in Washington State regulations.

One set of required analyses were not complete as of the writing of this report due to unavailability of test procedures. The assay for halogenated hydrocarbons is currently in progress and will be reported separately as soon as available. Based on the analytical data from the GM/MS and GC/FID assays for PCB's, neither PCB's nor halogenated hydrocarbons are present in the scrubber solids.

6/30/83

The scrubber solids were also analyzed for trace metals specified in the order and the data are included.

Based on the physical and chemical data developed in these investigations, it is concluded that the amounts and location of scrubber solids has been accounted for. Further, it is concluded that these scrubber solids would be characterized as "extremely hazardous wastes" under Washington State Regulations.

The Tacoma Works of Kaiser Aluminum has initiated an investigation of alternative management techniques. The results of these investigations will be presented to the Department of Ecology at a later date.

TABLE OF CONTENTS

DEPARTMENT OF ECOLOGY

IN THE MATTER OF DETERMINING SLUDGE EFFECTS ON WATER QUALITY BY THE KAISER ALUMINUM AND CHEMICAL CORPORATION, TACOMA WORKS	))))	ORDER No. DE 83-197

TO: Kaiser Aluminum and Chemical Corporation
3400 Taylor Way
Tacoma, WA 98421

During a recent survey at its Tacoma Reduction Works, the Kaiser Aluminum and Chemical Corporation discovered that sludges generated by past methods of air pollution control may be contaminating ground and surface waters. A preliminary analysis indicates that the sludge contains significant levels of polynuclear aromatic hydrocarbons, and may also contain other pollutants.

Therefore, in accordance with provisions of chapter 90.48 RCW, the Kaiser Aluminum and Chemical Corporation, herein after called the company, is ordered to perform the following activities.

(1) Plan and perform a study to determine the quantity and characteristics of the sludge. A study plan shall be submitted for department approval on or before April 22, 1983.

(2) Plan and perform a sampling program for surface waters, ground waters, and sediments. The sampling plan shall be submitted for department approval on or before April 22, 1983.

(3) Results of the study and sampling described in activities (1) and (2) shall be completed and the results submitted to the department on or before July 1, 1983.

DATED at Olympia, Washington this 15th day of April 1983.

John F Spencer

JOHN F. SPENCER
DEPUTY DIRECTOR
DEPARTMENT OF ECOLOGY
STATE OF WASHINGTON

STUDY PLAN

KAISER ALUMINUM & CHEMICAL CORPORATION
TACOMA WORKS

STUDY PLAN FOR DETERMINING SLUDGE EFFECTS ON WATER QUALITY

INTRODUCTION

Department of Ecology (DOE) Order No, DE-83-197, dated April 15, 1983 orders Kaiser to:

(1) Plan and perform a study to determine the quantity and characteristics of the sludge. A study plan shall be submitted for department approval on or before April 22, 1983.

(2) Plan and perform a sampling program for surface waters, ground waters, and sediments. The sampling plan shall be submitted for department approval on or before April 22, 1983.

(3) Results of the study and sampling described in activities (1) and (2) shall be completed and the results submitted to the department on or before July 1, 1983.

This study plan has been prepared to meet the requirements in paragraphs (1) and (2) that a plan be submitted for department approval. Organization of this plan is as follows:

		DATE
PREPARED BY	Paul F. Schmeil (signed) Paul F. Schmeil	5-17-83
REVIEWED BY	John T. Baker (signed) John T. Baker	5-17-83
APPROVED BY	Department of Ecology	

1.0 BACKGROUND

During the period from the early 1950's to mid-1974 the potroom exhaust gases were scrubbed with water which reduced fluoride, particulate and SO_2 emissions. The water was treated with lime and discharged to a pond west of Potline IV for solids settling. This scrubber sludge was dredged on two occasions and placed in sludge impoundments west of the ponds. The sludge is now located in the following three areas as outlined on Kaiser's drawing:

Area I   Existing Ponds.

Area II   Dredged material disposal area north of experimental Potline V.

Area III   Diked dredged material disposal area west/northwest of experimental Potline V.

During a geotechnical study in December 1982, two soil samples (sludge) had a detectable hydrocarbon odor and upon analysis were found to contain significant levels of Polynuclear Aromatic Hydrocarbons (PAH's). Findings were reported to DOE and EPA.

2.0 QUANTIFICATION AND SAMPLING OF SLUDGE

Appropriate safety precautions including rubber gloves and wash up afterwards will be used during sampling and handling of the sludge.

2.1 Area I

1. Review past dredging records and survey to identify probable depth of ponds.

2. Sound the ponds with a sounding rod working from a small boat.

3. Obtain sludge samples at eight sites using a piston sampler operated from a boom truck. Two foot long cores will be obtained from the bottom of each site by activating the piston sampler about one foot above the pond bottom, such that both the lower portion of the sludge and the upper natural soil is sampled. Two samples from each bottom core, a top sample and a bottom sample, will be saved for chemical analysis. At five locations (where the sludge is thicker) samples will be obtained closer to the surface of the sludge. This sampling will provide a total of 21 samples from Area I for chemical analysis.

2.2 Area II

1. Probe with a backhoe and by hand to identify depth of sludge.
2. Obtain at least four sludge samples from backhoe test pits using good sampling techniques to obtain representative samples.

2.3 Area III

1. Probe with backhoe and by hand at as many locations as are necessary to identify depth and quantity of the sludge.
2. Obtain six sludge samples or more if necessary to identify the extent of sludge in Area III using good sampling techniques to obtain representative samples.

3.0 CHARACTERIZATION OF THE SLUDGE

3.1 Chemical Analysis

3.1.1 One representative sample of the sludge from each area (3 sludge samples total) will be analyzed for the items listed in Table I.

3.1.2 In determining whether the 31 sludge samples are EHW (1% or greater PAH) or not designated as a dangerous waste, the DOE procedure "Analysis for Polynuclear Aromatic Hydrocarbon," will be used to obtain values for reporting where the PAH values are close to the 1% decision point.

However, in the interest of reducing analytical expenses and obtaining the most useful information during this study, the following adaptations of the methods will be used. The results we would obtain will be higher than those obtained by the DOE method. The procedures will be used to eliminate from further consideration samples which show allowable low levels or exceed the 1% "decision point" by a factor of 2 (i.e. samples having PAH values >2% or <1.0%).

The following techniques have been developed on

---

the basis of Kaiser Aluminum's previous studies of this particular waste site and will be used when appropriate:

(1) All samples will be dried and our determination will be made by extraction of the dried material. Previous studies showed some samples can be over 50% water. The original moisture content shall be determined so that any "correction" desired can be made. We see no problem in loss of PAH by volatilization during drying as we are not concerned with the most volatile species (< 4 rings).

(2) For survey samples an initial extraction with methylene chloride or chloroform will be made followed by a gravimetric measurement of the residue. The results of this analysis will ALWAYS be higher than the DOE procedure due to the greater extractive power of the solvent and its non-selectivity.

* If the result is < 1% PAH, except for the sediment samples, we will report that value and do no further work on the sample.

* If the result is > 2% PAH, and we believe that there is not sufficient reason to expect that the value obtained by using the DOE's method would closely approach, or fall below, the 1% decision point, we will merely report the value obtained and do no further work on the sample.

* For those samples which we believe will show, by the DOE method, PAH values very close to the 1% decision point, we shall either (a) take the methylene chloride extract, pour it over sand, dry it, and extract it with pet.either, or (b) take a new aliquot of the dry sample and extract it. From that point, we shall follow the State's procedure.

(3) In those cases where the PAH value exceeds the 1% decision value, the State allows for a correction to be made by subtracting the quantity of material derived from species having fewer than four rings and greater than six rings. They recommend EPA method 8310 which utilizes HPLC or an equivalent.

We propose the following approach as being equivalent.

Due to the solubility limitaions of pet.ether, we do not believe that enough material having >6 rings will be present to make it worth the bother to correct for it. On the other hand, we know that for the sludge at the Tacoma site, a significant correction can and should be made for the material having fewer than 4 rings. We propose using gas chromatography to quantitatively measure the portion of the extract which is composed of fewer than 4 rings. By definition, we shall designate the compounds having <4 rings as those species which elute from the gas chromatograph prior to fluoranthene.

3.2 Physical Characteristics

Terrel Associates, Inc. will conduct a soil characterization study of the sludge including soil classification, Atterberg limits, gradation analysis, compaction (-15 pt. method), strength, volume change, reactivity, and permeability.

3.3 Toxicological Evaluation

The sludge is toxic and it is known that the lethal concentration for this material is in the range of 100 ppm. Information on the constituent materials that are acutely toxic and water soluble would be valuable to aid in the final selection of stabilizing materials for containment and clean-up. The sludge sample will be fractionated and from the nature of the fractionation and spectrophotometric analysis, the group or class of compounds (i.e. phenolics or other organics) that are responsible for acute toxic effects on fish will be identified. Five to ten bioassays are planned.

4.0 SURFACE WATER AND SEDIMENT SAMPLES

Three bottom sediment samples and three water samples will be collected at the following locations in the main ditch which passes between sludge Areas I and II:

(1) Upsteam near the BPA property line (south end of Kaiser's property).

(2) Intermediate point located at the north end of the ponds after the drainage point from Area II.

(3) Downstream near Taylor Way (north boundary of Kaiser's property).

Each of the three water samples will be a composite sample collected each 1/2 hour over a 5 to 6 hour period during an outgoing tide. Flows will be measured at points 2 and 3 using a Marsh-McBurney meter each time a surface water sample is collected.

In addition, three composite samples will be collected during an outgoing tide at the same locations during a heavy rainfall IF such occurs AND scheduling of personnel for sampling can be coordinated.

One sediment sample will be collected by continuously filtering the suspended solids from the water (about 1 gpm) at Station #2 during the 5 hour period when the three composite water samples are being collected.

Also, two sediment or soil samples will be collected from the marshy area located between the north end of Area II and the south end of the log storage area.

5.0 GROUND WATER SAMPLING

Ground water samples will be collected from the shallow depth piezometer wells at locations R, T, and U as shown on Kaiser drawing 10.3.9-2. Samples from locations L, M, N and H were collected previously and evaluated. The results from location L will be reviewed and this location may again be sampled.

6.0 CHEMICAL ANALYSIS OF WATER AND SEDIMENT

The water samples collected in paragraphs 4.0 and 5.0 will be analyzed for those items listed in Table I. Limit of detection for PAH's will be 10 ppb. Suspended matter in the water is assumed to have the same composition as the sediment. If it is not removed, the results will only reflect the sediment value. Therefore, the suspended matter will be removed by means of a 0.5 micron glass filter in accordance with NOAA Technical Memorandum OMPA-12. The water samples will be analyzed by EPA method 625 or 610, or equivalent. If interferences aren't too great, we should find it relatively easy to adapt our GC analysis to measure the components sufficiently to get a "Total PAH" value.

Analysis of the sediment samples will be similar to the sludge samples as detailed in paragraph 3.1.2. (See Table I)

KAISER ALUMINUM & CHEMICAL CORPORATION
TACOMA WORKS

STUDY PLAN FOR DETERMINING SLUDGE EFFECTS ON WATER QUALITY

APRIL 21, 1983 R1: MAY 16, 1983

TABLE I (page 1 of 2)
SLUDGE MANAGEMENT PROJECT ANALYTICAL RESULTS

Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1
	SOLIDS									WATER									
	Sludge			Ditch Sediment			Sus.	Marsh Area		Drainage Ditch						Ground Water			
	I	II	III	1	2	3	Solids	#1	#2	1	2	3	1-rain	2-rain	3-rain	8PS R	1PS T	9PS U	1
1. Priority Pollutant Base Neutals PNA'S																			
-Acenaphthene																			
-Acenaphthylene																			
-Anthracene																			
-Benzo(a)Anthracen																			
-Benzo(a)Pyrene																			
-3,4Benzofluor- anthene																			
-Benzo(ghi)Perylen																			
-Benzo(k)Fluor- anthene																			
-Chrysene																			
-Dibenzo(a,h)- Anthracene																			
-Fluoranthene																			
-Fluorene																			
-Indeno(1,2,-cd)- Pyrene																			
-Naphthalene																			
-Phenanthrene																			
-Pyrene																			
2. Additional PNA's																			
-Benzo(e)pyrene																			
-Benzo(ghi)- Fluoranthene																			
-Methyl Fluoranth- enes/Methyl - Pyrenes																			
-Methyl Fluoranth- enes/Methyl - Anthracenes																			
-4 Methyl Phenan- threne																			
-9 Methyl Phenan- threne																			
-2 Phenyl Naphthalene																			
-1 Methyl Pyrene																			

TABLE I (page 2 of 2)
SLUDGE MANAGEMENT PROJECT ANALYTICAL RESULTS

Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	SOLIDS									WATER									
	Sludge			Ditch Sediment			Sus.	Marsh Area		Drainage Ditch						Ground Water			
	I	II	III	1	2	3	Solids	#1	#2	1	2	3	1-rain	2-rain	3-rain	L 8PS	R 1PS	T 9PS	U 13PS
3. Halogenated Hyrocarbons (using WDOE procedure)																			
4. Trace Metals																			
-Antimony																			
-Arsenic																			
-Beryllium																			
-Cadmium																			
-Chromium																			
-Copper																			
-Lead																			
-Mercury																			
-Nickel																			
-Selenium																			
-Silver																			
-Thallium																			
-Zinc																			
5. Polychlorinated Biphenyls (PCB's)																			

KAISER ALUMINUM & CHEMICAL CORPORATION
TACOMA WORKS

STUDY PLAN FOR DETERMINING SLUDGE EFFECTS ON WATER QUALITY

APRIL 21, 1983 R1: MAY 16, 1983

TABLE II

PROJECT TEAM FOR SLUDGE EVALUATION

KAISER ALUMINUM - TACOMA WORKS

Paul Schmeil	(206) 593-0716
John Baker	(206) 593-0701
Ron Schutz	(206) 593-0728
Dick Davidson - Technician	(206) 383-1461, Ext. 314

KAISER ALUMINUM - OAKLAND

Dr. Jack Schwegmann	(415) 271-3341
Ed Paille	(415) 271-5403

KAISER ALUMINUM CENTER FOR TECHNOLOGY (CFT)

(Responsible for Analytical Work)

Tom Lowe, Manager Analytical Research Service	(415) 462-1122
Dr. Bill Hanneman, Ph.D Organic Chemistry	(415) 462-1122

LANDAU & ASSOCIATES

(Responsible for Geotechnical Work and Assistance in Project Coordination)

Dr. Hank Landau, Ph.D Geotechnical Engineering	(206) 542-4917

TERREL ASSOCIATES

(Responsible for Soil Stabilization Studies)

Dr. Ron Terrel, Ph.D Civil Engineering	(206) 542-9223

DR. ROLF HARTUNG

(Responsible for Providing Advice on Toxicity Aspects)

Dr. Rolf Hartung, Chairman Department of Toxicology, University of Michigan	(313) 971-9690

E.V.S. CONSULTANTS

(Responsible for Running Tests and Evaluating Toxicity of Sludge)

Dr. Gary Vigers	(604) 986-9331
Dr. Bob Dexter	(206) 623-3074

CONTACTS IN WASHINGTON - DEPARTMENT OF ECOLOGY (DOE)

Dick Burkhalter	(206) 459-6027
Fred Fenske	(206) 459-6035
Roger Stanley	(206) 459-6031
Bill Yake	(206) 753-2891
Merley McCall Lab.	(206) 754-2532

Comments To Study Plan

JO SPELLMAN
vernor

DONALD W. MOOS
Director

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Mail Stop PV-11 • Olympia, Washington 98504 • (206) 459-6000

May 26, 1983

Mr. J. T. Baker
Kaiser Aluminum and Chemical
Corporation
3400 Taylor Way
Tacoma, Washington 98421

Dear Mr. Baker:

The department has reviewed the study plan you submitted in your May 19 letter in response to DOE Order 83-197.

As you know, the study is in progress and we have participated in parts of it. The plan is generally acceptable to the department with the following exceptions:

1) A question still remains with the proposal to dry the sludge samples prior to extraction. If the samples are dried, a check should be made to determine if any PNA losses are occurring.

2) The procedure of filtering the ditch water samples is unacceptable. Both the filtered solids and the supernate should be analyzed to determine the actual loading to the waterway.

3) There are some questions regarding the ground water monitoring approach. We understand that the consultant has determined the local flow, but these data have not been reported to the department. If the proposed wells to be sampled can reasonably be expected to describe any subsurface transport of the sludge elements, then the information should be provided. In the event that the existing wells are not adequate, additional wells should be installed.

We are confident that these exceptions can be readily resolved, and we concur that the study should proceed as scheduled.

Sincerely,

Donald O Provost

Donald O. Provost
Special Assistant

DOP:bjw

cc: Fred Fenske

TECHNICAL MEMORANDUM

P. F. Schmell
Tacoma

Date June 1, 1983

From W. W. Hanneman WWH

Subject

Copies To

My response to Items 1 and 2 from D. O. Provost's memo of May 26, 1983, to J. T. Baker concerning our analytical work is presented below.

Item 1

It appears that there was an oversight on our part in not specifically stating that the sludge samples would be air dried at ambient temperatures (<75° F).

We have been analyzing coal tar pitch volatile samples for over 12 years. We have already made numerous checks to demonstrate no significant loss of PNA's (>4 rings) from both solid materials such as these sludges and pure extracts. Perhaps we should mention that our laboratory did the fundamental work on the method for determining coal tar pitch volatiles which is now accepted as the standard OSHA method.

Item 2

I am pleased to hear the investigators have recognized the information that is really desired is the actual loading to the waterway.

After reading NOAA Technical Memorandum OMPA-12 (Paragraph 3.9) in which it states the PNA partitioning between solids and water is on the order of 100,000:1 (a number which we have confirmed from our independent studies), it made little sense to me to (1) independently measure both filtered water and sediment, (2) multiply the values by their appropriate weight factors, and (3) sum the results in order to get the same value which could be readily obtained by merely running the straight sample without separation.

The only problem associated with this latter approach is how to report the data. To resolve this, I propose changing the headings of columns 10-15 (Table I, attached) to "Loading" to Waterway and expressing the value in µg/L.

WWH:jh
Attachment

KAISER ALUMINUM & CHEMICAL CORPORATION
TACOMA WORKS

STUDY PLAN FOR DETERMINING SLUDGE EFFECTS ON WATER QUALITY

APRIL 21, 1983 R1: MAY 16, 1983

TABLE I (page 1 of 2)
SLUDGE MANAGEMENT PROJECT ANALYTICAL RESULTS

Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	19
	SOLIDS [1]									"LOADING" TO WATERWAY [2]						WATER [3]			
	Sludge			Ditch Sediment			Sus. Solids	Marsh Area		Drainage Ditch						Ground Water			
	I	II	III	1	2	3		#1	#2	1	2	3	1-rain	2-rain	3-rain	8PS R	1PS T	9PS U	13PS
1. Priority Pollutant Base Neutals PNA'S																			

[1] Values expressed in µg/kg

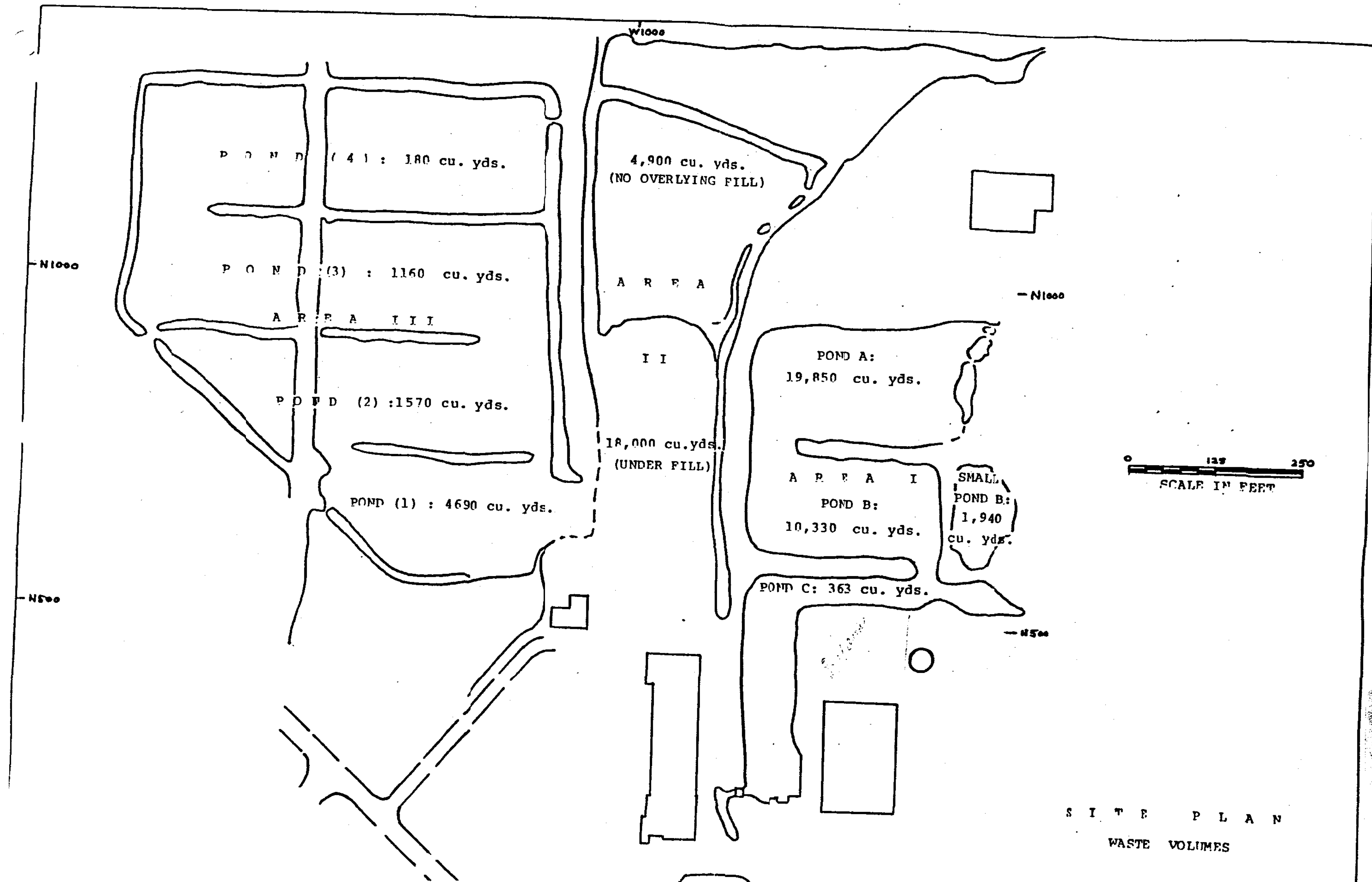
[2] Values expressed in µg/L "Loading" to Waterway represent the sum of the material dissolved in the water and that adsorbed on suspended matter. The partitioning ratio of PNA's between solid matter and water is approximately 100,000:1.

[3] Values expressed in µg/L.

QUANTITY OF SLUDGE ON PLANT SITE

SLUDGE QUANTITIES

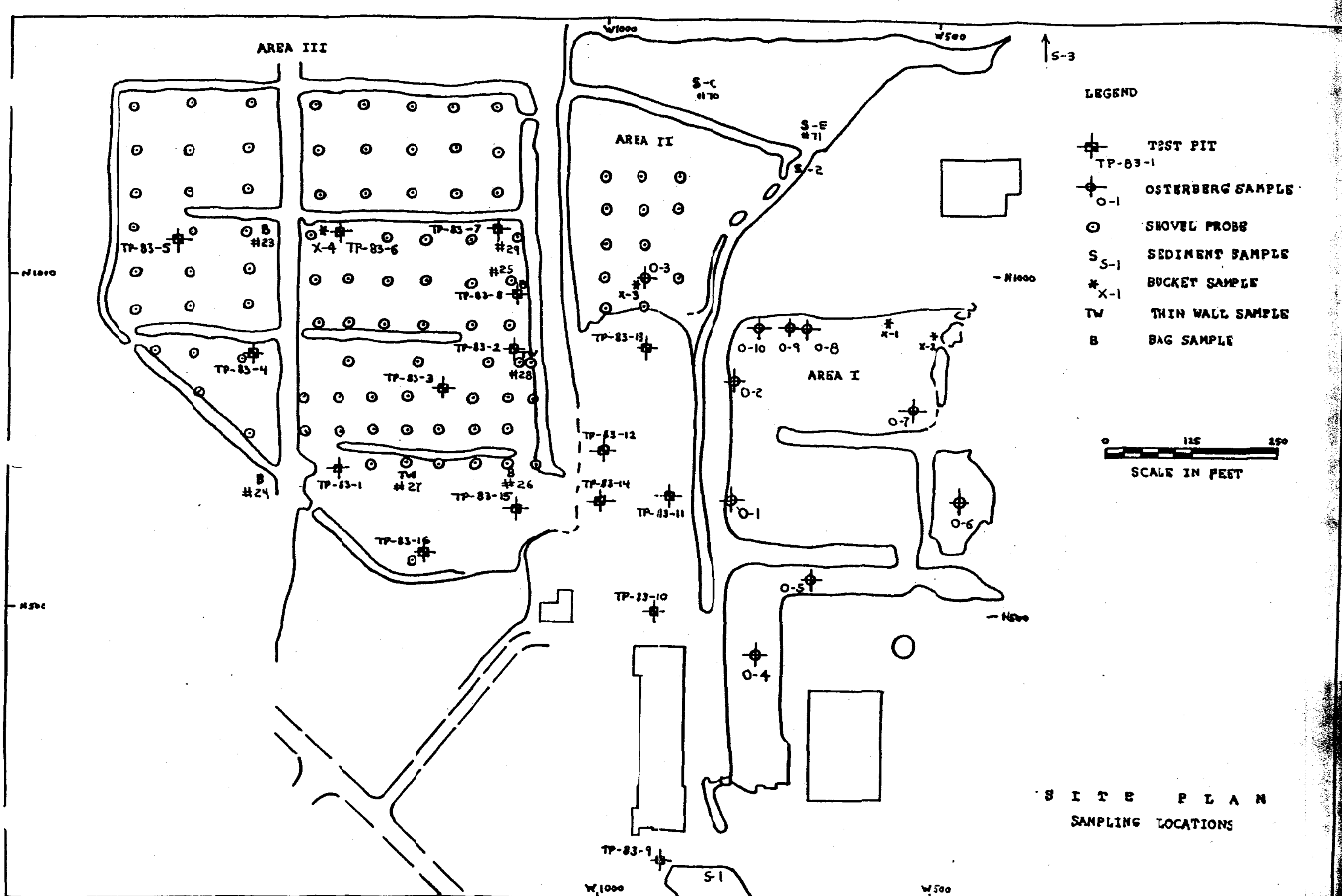
AREA	VOLUME CU. YDS.	WATER CONTENT WATER WT/SOLIDS WT X 100	WEIGHT WET TONS	DRY TONS
I	32,500	115%	39,000	18,000
II	22,900	45%	34,300	23,800
III	7,600	45%	11,400	4,600
TOTAL	63,000		84,700	46,400



SITE PLAN

WASTE VOLUMES

SOURCE DATA FOR QUANTIFICATION



SITE PLAN
SAMPLING LOCATIONS

OSTERBERG SAMPLING PROCEDURE USED IN AREA 1 PONDS

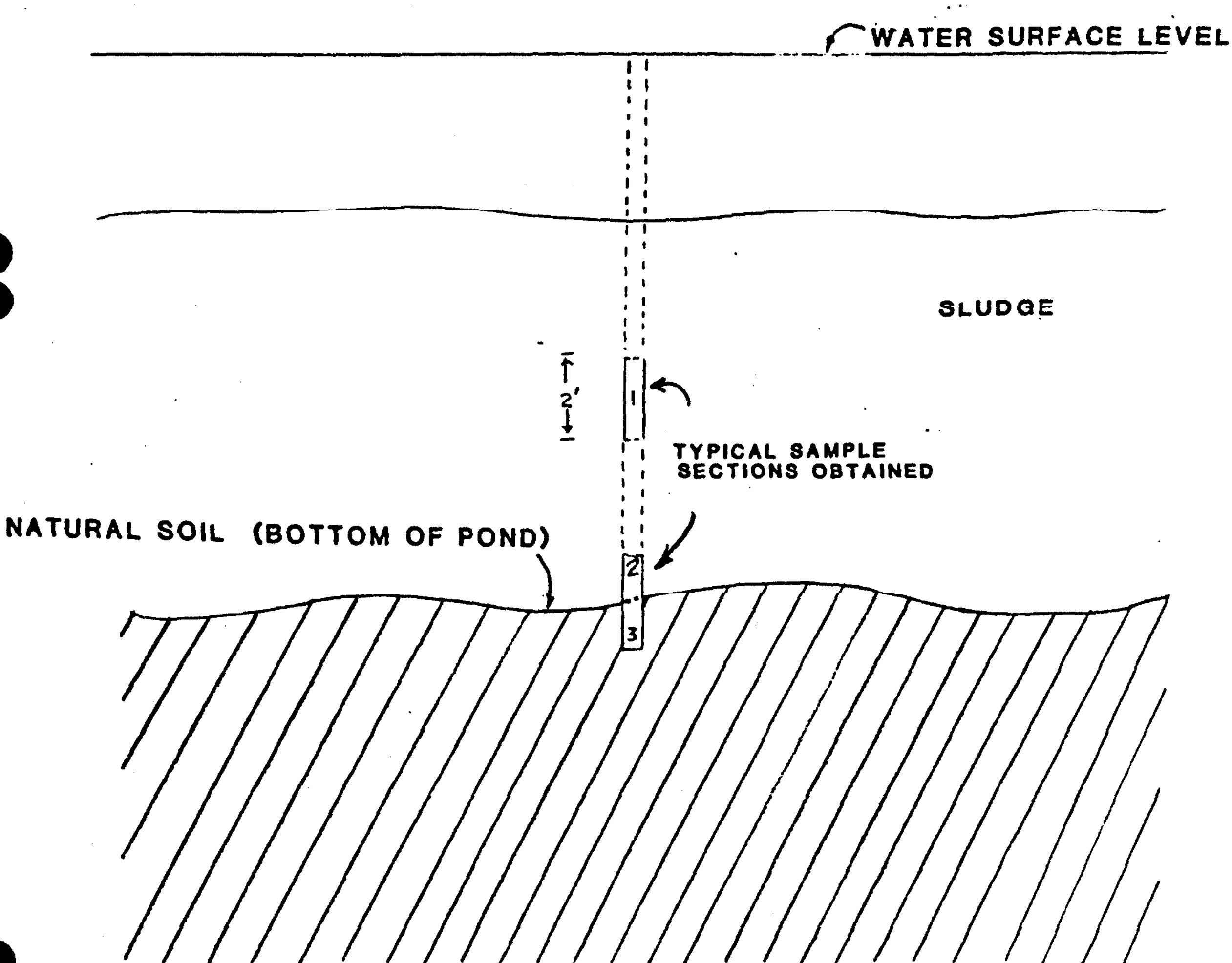


TABLE I

SAMPLES COLLECTED FOR SLUDGE INVESTIGATION
(AREA I SAMPLES)

Seq. No.	DATE SAMPLED	MATERIAL TYPE	AREA	LOCATION/ DESIGNATION	DEPTH	SAMPLING METHOD	SAMPLED BY	SAMPLE #	* % EXTRACTABLES	COMMENTS
1	12/2/82	Sludge	I				CH2M Hill	J-3	5.20	
16	3/4/83	Sludge	I				Kaiser		5.69	(corrected to 4.80%) -Sample extentively analyzed
18	4/27/83	Sludge	I	X-2	1 ft.	Shovel	LA	A	4.66	-To U of W for soil work.
36	5/11/83	Sludge	I	0-1	2.5 -5'	Osterberg	LA	K-16	4.78	
37	5/11/83	Sludge	I	0-1	6.5 - 9'	Osterberg	LA	K-10	3.94	
38	5/11/83	Soil	I	0-1	9'	Osterberg	LA	K-12	0.17	
39	5/11/83	Sludge	I	0-2	2.5 - 5'	Osterberg	LA	K-17	5.94	-Split with DOE-
40	5/11/83	Sludge	I	0-2	2.5 - 5'	Osterberg	LA	K-27	5.70	-K27 is duplicate of K17
41	5/11/83	Sludge	I	0-2	7 - 9.5'	Osterberg	LA	K-26	4.81	
42	5/11/83	Soil	I	0-2	9.5'	Osterberg	LA	K-13	0.02	
43	5/11/83	Sludge	I	0-4	5 - 7.5'	Osterberg	LA	K-21	1.38	
44	5/11/83	Soil	I	0-4	7.5'	Osterberg	LA	K-42	0.13	
45	5/11/83	Soil	I	0-4	9.5'	Osterberg	LA	K-19	0.11	
46	5/11/83	Soil	I	0-4	12'	Osterberg	LA	K-22	0.18	
47	5/11/83	Sludge	I	0-5	5.5 - 8'	Osterberg	LA	K-25	0.65	
48	5/11/83	Soil	I	0-5	8'	Osterberg	LA	K-20	0.07	
49	5/11/83	Sludge	I	0-6	8 - 10.5'	Osterberg	LA	K-15	2.82	
50	5/11/83	Soil	I	0-6	10.5'	Osterberg	LA	K-29	0.10	
51	5/11/83	Sludge	I	0-7	0.5 - 3'	Osterberg	LA	K-14	4.90	
52	5/11/83	Sludge	I	0-7	9.5 - 11'	Osterberg	LA	K-34	4.71	
53	5/11/83	Soil	I	0-7	12'	Osterberg	LA	K-33	0.02	
54	5/11/83	Sludge	I	0-8	2.5 - 5'	Osterberg	LA	K-39	3.77	
55	5/11/83	Sludge	I	0-8	9 - 10.5'	Osterberg	LA	K-24	4.69	
56	5/11/83	Soil	I	0-8	12'	Osterberg	LA	K-40	0.01	
57	5/11/83	Soil	I	0-8	13'	Osterberg	LA	K-35	0	
58	5/11/83	Sludge	I	0-9	6.5 - 9'	Osterberg	LA	K-31	4.46	
59	5/11/83	Sludge	I	0-10	3 - 5.5'	Osterberg	LA	K-28	5.57	
60	5/11/83	Sludge	I	0-10	9 - 11.5'	Osterberg	LA	K-41	5.12	
61	5/11/83	Soil	I	0-10	10.5-11.5	Osterberg	LA	K-32	0.03	

*% Extractables is the amount of material dissolved by methylene chloride.

TABLE II

SAMPLES COLLECTED FOR SLUDGE INVESTIGATION
(AREA II SAMPLES)

Seq. No.	DATE SAMPLED	MATERIAL TYPE	AREA	LOCATION/ DESIGNATION	DEPTH	SAMPLING METHOD	SAMPLED BY	SAMPLE #	* % EXTRACTABLES	COMMENTS
2	12/2/82	Sludge	II				CH2M Hill	TP-103	4.50	
19	4/27/83	Sludge	II	X-3		Shovel	LA	B	1.99	-To U of W for soil work.
** 30	5/9/83	Sludge	II	TP83-11	12 - 14'	Backhoe	LA	K-1	.16	
31	5/9/83	Sludge	II	TP83-10	8 - 11'	Backhoe	LA	K-4	4.51	
32	5/9/83	Sludge	II	TP83-12	5 - 6'	Backhoe	LA	K-9	4.47	
35	5/11/83	Sludge	II	O-3	1.6 - 4'	Osterberg	LA	K-37	3.30	
34	5/11/83	Soil	II	O-3	4'	Osterberg	LA	K-18	.22	

*% Extractables is the amount of material dissolved by methylene chloride.

**Soil-Sludge mixture.

TABLE III

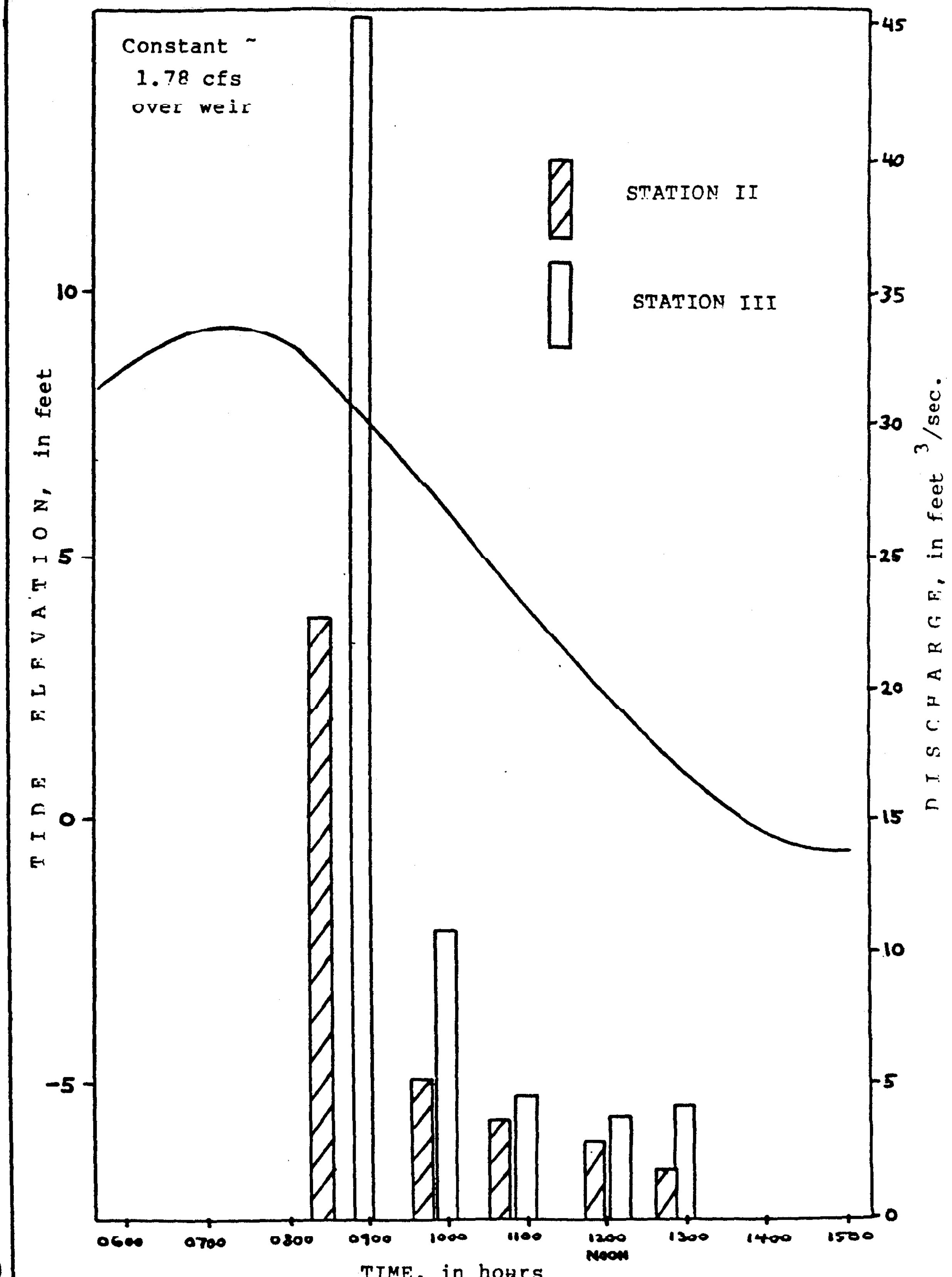
SAMPLES COLLECTED FOR SLUDGE INVESTIGATION
(AREA III SAMPLES)

Seq. No.	DATE SAMPLED	MATERIAL TYPE	AREA	LOCATION/ DESIGNATION	DEPTH	SAMPLING METHOD	SAMPLED BY	SAMPLE #	* % EXTRACTABLES	COMMENTS
3	2/8/83	Soil	III		0.5'	Shovel	D&M	#1	.002	
4	2/8/83	Soil	III		0.5'	Shovel	D&M	#2	.07	
5	2/8/83	Soil	III		0.5'	Shovel	D&M	#3	<.0006	
20	4/27/83	Sludge	III	X-4	1 ft.	Shovel	LA	C	3.32	-To U of W for soil work.
21	5/9/83	Sludge	III	TP 83 7	1 ft.	Backhoe	LA	K-2	3.86	
22	5/9/83	Soil	III	TP 83 7	2.5'	Thin wall	LA			
23	5/9/83	Sludge	III	TP83-5 + 120E	0.5'	Shovel	LA	K-5	1.38	
24	5/9/83	Sludge	III	TP83-4 + 120S	0.5'	Shovel	LA	K-6	1.46	
25	5/9/83	Sludge	III	TP83-7 + 75SE	1'	Shovel	LA	K-7	1.46	
26	5/9/83	Sludge	III	TP83-1 + 260E	1'	Shovel	LA	K-8	.97	
27	5/9/83	Sludge	III	TP83-1 + 100E	0.5'	Thin wall	LA			
28	5/9/83	Sludge	III	TP83-2 + 50E	0.5'	Thin wall	LA			
29	5/9/83	Sludge	III	TP83-7 + 75SE	0.5'	Shovel	LA	K-3	2.56	

*% Extractables is the amount of material dissolved by methylene chloride.

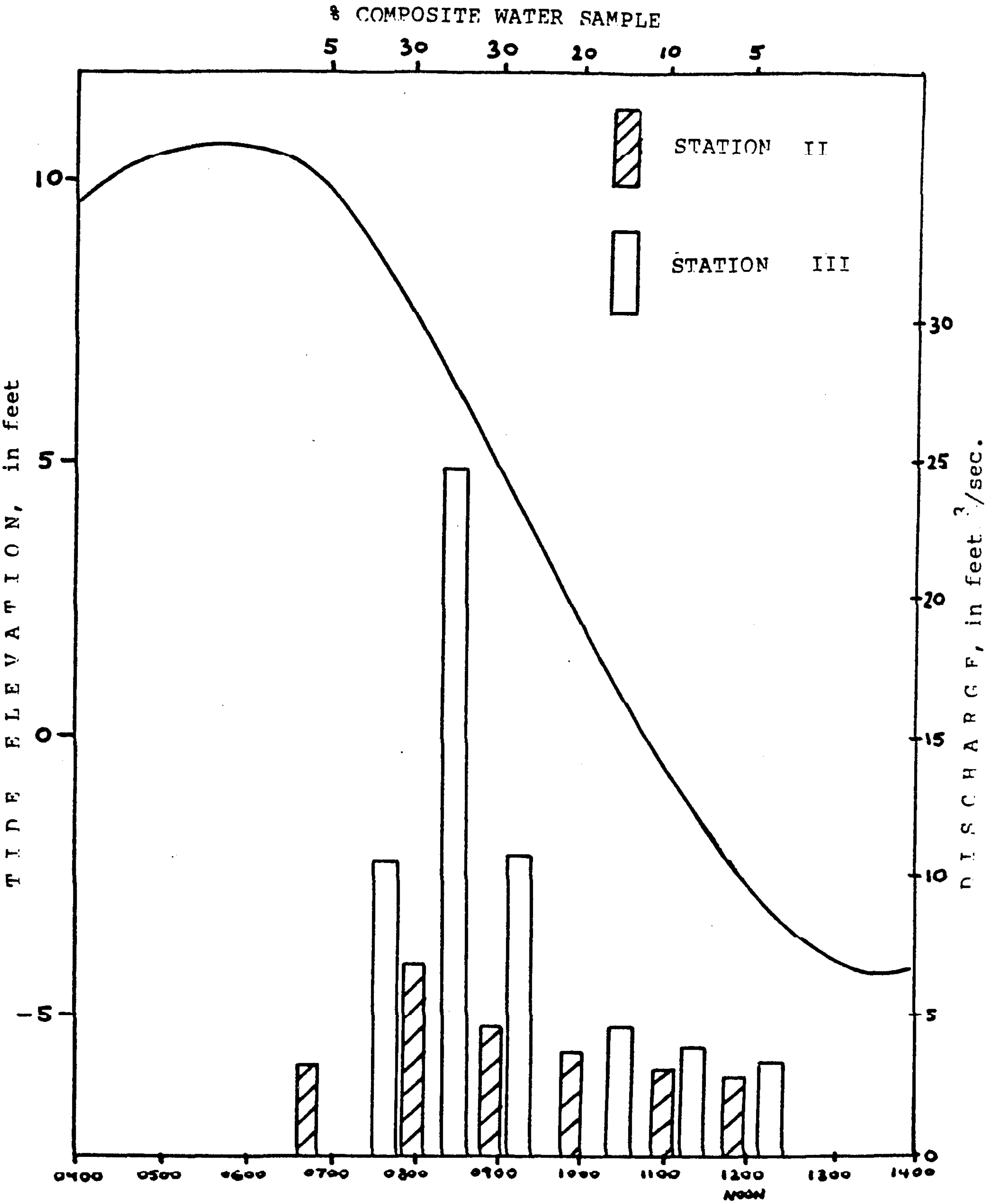
DITCH FLOW MEASUREMENTS

(Using Marsh McBurney Meter)



T I D E vs. D I S C H A R G E

TUESDAY, MAY 31, 1983



TIME, in hours

T I D E vs. D I S C H A R G E

MONDAY, JUNE 13, 1983

DETAILED CHEMICAL RESULTS

FOR CHARACTERIZATION

OF

SLUDGE

SEDIMENT

MARSH AREA

LOADING TO WATERWAY

&

GROUND WATER

TABLE I (page 1 of 2)
SLUDGE MANAGEMENT PROJECT ANALYTICAL RESULTS

Sa[redacted]Sequence Number	39	19	20	66	67	68	69	70	71	72	73	74	76	77	78	79
	S O L I D S									LOADING TO WATERWAY (1)			W A T E R			
	Sludge			Ditch Sediment			Sus.	Marsh Area		Drainage Ditch			Ground Water			
	I	II	III	S-1	S-2	S-3	Solids	#1	#2	1	2	3	R 1PS	T 9PS	U 13PS	M 21I
Percent Extractables	5.94	1.99	3.32			1.20 <1% PAH major constituant.		1.08 Sulfer	0.11							
1. Priority Pollutant Base Neutals PAH's	(results expressed as micrograms/gram of sample or ppm)															
-Acenaphthene	27	3	8	1	.05	8	0.2									
-Acenaphthylene	--	--	--	--	--	--	--									
-Anthracene	890	90	141	8.8	0.24	90	8									
-Benzo(a)Anthracene	870	500	480	17.1	1.35	170	43	0.7	0.01							
-Benzo(a)Pyrene	430	460	390	9.4	1.80	96	37	0.9								
-3,4Benzofluoranthene	750	750	730	11.3	3.15	160	68	1.5								
-Benzo(ghi)Perylene	270	670	370	7.0	1.74	55	43									
-Benzo(k)Fluoranthene	270	450	400	10.0	1.56	80	33	1.5								
-Chrysene *	1060	930	760	21.9	3.75	205	75	0.9	0.02							
-Dibenzo(a,h)-Anthracene	600	540	300	6.3	0.32	32	50									
-Fluoranthene	4620	1650	1700	78.8	2.33	760	99	1.2	0.06							
-Fluorene	180	12	30	3.5	0.10	32	0.8									
-In[redacted](1,2,-cd)- Pyrene	125	320	180	3.5	0.92	25	17									
-Na[redacted]alene	--	--	--	--	--	--	--									
-Phenanthrene	4720	230	570	21.9	0.46	640	29									
-Pyrene	4800	2000	1900	77.5	3.08	740	113	0.5	0.08							
2. Additional PAH's																
-Benzo(e)pyrene	650	590	600	15.6	3.59	138	68	3.0								
-Benzo(ghi)-Fluoranthene	200	125	116	4.4	0.17	38	14									
-Methyl Fluoranthenes/Methyl Pyrenes	950	600	530	21.3	1.03	222	68									
-Methyl Fluoranthenes/Methyl Anthracenes	(meaningless in light of the above entry.)															
-4 Methyl Phenanthrene	600	55	72	5.6	0.12	98	5.7									
-9 Methyl Phenanthrene	780	125	100	1.6	0.05	21	6									
-2 Phenyl Naphthalene	520	44	116	7.1	0.16	67	8									
-1 Methyl Pyrene **	200	30	26	2.0	0.03	20	3									
Total PAH's (%)	2.35	1.02	0.95	0.03	.0024	0.37	0.08	0.00	0.00							

Results for samples 72, 73, 74, 76, 77, 78, and 79 were all below 10 ppb for each of the PAH's listed in 1 & 2.

Notes:

* Chrysene separated from Triphenylene.
[redacted]ample 66 consisted of 87.5% rocks.
[redacted]amples 70 and 71 from the marsh area contained sulfur and other interferences.
** Values for -1 methyl pyrene included in methyl pyrenes reported above.

(1) Values expressed in ug/L"Loading" to Waterway represent the sum of the aterial dissolved in the water and that adsorbed on suspended matter. The partitioning ratio of PAH's between solid matter and water is approximately 100,000:1.

TABLE I (page 2 of 2)
SLUDGE MANAGEMENT PROJECT ANALYTICAL RESULTS

Sample Sequence Number	-39-	-19-	-20-
	Sludge		
Area :	I	II	III

3. Halogenated Hyrocarbons (using WDOE procedure)

Analytical work not complete because of misunderstanding between the analytical labs. Results will be provided later.

4. Trace Metals

Total Metals Expressed as micrograms/gram (on wet basis)

	I	II	III
-Antimony	63	53	52
-Arsenic	8	5	2
-Beryllium	<5	<5	<5
-Cadmium	<5	<5	<5
-Chromium	21	13	14
-Copper	110	87	59
-Lead	6	13	10
-Mercury	<0.1	0.3	0.2
-Nickel	110	500	360
-Selenium	<0.1	<0.1	<0.1
-Silver	<5	<5	<5
-Thallium	--	--	--
-Zinc	11	17	19
% Water	62	47	45

5. Polychlorinated Biphenyls (PCB's)

No evidence of PCB's or Pesticides found in any of the samples. Examination made by GC/MS and also GC/FID. Limits of detection are less than 10 ppb.

OTHER CHEMICAL RESULTS

TECHNICAL MEMORANDUM

P. F. Schmeil
Tacoma

Date: May 9, 1982

From: L. R. Barsotti
Leo

Subject: Pond Sludge
ARD No. 134274

Copies To
W. W. Hanneman - CFT 20
T. A. Lowe - CFT 08
J. M. Winkler - CFT 20

ABSTRACT

Tacoma pond sludge was analyzed. Major constituents were water, Al_2O_3, CaF_2 and carbon/organics.

* * * * *

The Tacoma pond sludge, dated March 4, 1983, and submitted to ARD on April 13, 1983, has been analyzed. Because of necessary sample preparation, all the data are not on an equivalent basis. However, a few simple calculations show the data to be reasonable and consistent. The sample as received was a sludge with free liquid, so the entire sample was well dispersed and portions removed for analyses.

The data are given in Table I.

Should you have any questions after reviewing the data, please call me.

LRB:jh

Attachments

SAMPLE IS SEQUENCE #16 IN TABLE I

am test inc.

4900 9TH AVENUE N.W., • SEATTLE, WASHINGTON 98107-3697 • 206/783-4700

ANALYSIS REPORT

CLIENT: Kaiser Aluminum & Chemical Corp. DATE REPORTED: 3-31-83

REPORT TO: Mr. Paul Schmeil P.O.#07696
3400 Taylor Way
Tacoma, WA 98421

Analysis of Sediments for PAH's

Laboratory Sample No.	Client Identification	Amt. Ext.	PNA Residue Wgt.	% PNA Wgt.
57159	Pond Sludge 3-4-83	10.1g	0.575g	5.7%

PNA Residue Analysis

Napthalene	0.0156g*	
Acenaphthylene	0.0114g*	
Fluorene	0.0051g*	] 0.0901g
Anthracene	0.0070g*	
Phenanthrene	0.0510g*	
Fluoranthene	0.022g	
Pyrene	0.0657g	
Chrysene, Benzo(A)anthracene	0.0317g	
Benzo (b) Fluoranthene	0.009g	
Benzo (k) Fluoranthene	0.0054g	
Benzo (A) pyrene	0.004g	
Dibenzo (a,h) anthracene	0.004g	

*PAH's containing less than 4 rings are considered non-toxic. Corrected residue weight is .485g or 4.8% PAH's greater than 4 rings. Some of these were quantitated above.

cont....

AT

CLIENT: Kaiser Aluminum & Chemical Corp. DATE REPORTED: 3-31-83

REPORT TO: Mr. Paul Schmeil P.O.#07696

EP Toxicity

Laboratory Sample No. 57159

Client Identification	Pond Sludge - 3-4-83	Maximum Allowable Concentration
Arsenic	0.01	5.0
Selenium	<0.01	1.0
Lead	<0.50	5.0
Silver	<0.10	5.0
Chromium	<0.40	5.0
Cadmium	<0.05	1.0
Barium	<1.00	100.0
Mercury	<0.002	0.2
Initial pH	6.70	

All values in ppm (mg/l) of elutriate.

REPORTED BY Garry M. Duschl

Garry M. Duschl

nr

REPORT GIVEN TO WASHINGTON STATE

DEPARTMENT OF ECOLOGY ON 2/24/83

REPORT ON TACOMA LINE V SITE FINDINGS

During the geotechnical study, two soil samples collected by CH_2M Hill had a detectable hydrocarbon odor. CH_2M Hill analyzed the two samples and found high levels of aromatic hydrocarbons.

Splits of these two soil samples plus four other soil samples and eight (8) water samples were sent to Kaiser's research lab at CFT for analysis. The following is CFT's report.

SOIL SAMPLES

Our investigation revealed the presence of Poly Nuclear Aromatics (PNA's) in every sample of soil. The concentrations ranged from less than 2 ppm to over 5%. In an effort to simplify reporting and avoid overwhelming the reader with tables of numbers which are virtually incomprehensible, the report is broken down into two parts -- a description of the PNA material and the PNA results.

As you are well aware, the PNA's expected to be found at this site originated from the trapping of volatile components derived from coal tar pitch. This is exactly what we found. In every instance, the GC fingerprint (a reflection of composition) was virtually the same. It is well documented that coal tar pitch volatiles are composed of hundreds of individual species which one could measure individually if the time, money , and inclination were present. We have been studying pitch volatiles for the past ten years and have determined that for all practical purposes, pitch volatiles can be adequately derived by measuring about nine (9) individual components or isomer groups. Our analysis of the pitch volatiles showed the following composition.

PITCH VOLATILES COMPOSITION

Component	wt %
Anthracene/Phenanthrene	18
Fluranthene/Pyrene	35
Benzo (a) anthracene/Chrysene	6
Benzofluoranthene isomers	5
Benzo(a&e)pyrene	2
Total of Above	66

It can be noted here, that the above species comprise only about 15 to 20 percent of typical coal tar pitch. This confirms the fact that these components in the Tacoma samples are derived from volatiles.

In order to determine concentrations of individual species in any of the data reported below for PNA contents, one need only to multiply the concentration of PNA reported by the concentration of the individual specie reported above.

The two soil samples collected by CH_2M Hill (J-3, and TP-103, 12/14/82) contained very high levels of PNAs. We found by gravimetric methods values of 5.2% and 4.5% respectively. These values are based on air dried sample weights. As received, these samples contained about 50% water. We found that over 80% of the gravimetric value could be measured by gas chromatography. This also confirmed the origin of the material as being from volatiles.

TA TERREL ASSOCIATES, INC.
9703-241st Pl. S.W., Edmonds, Washington 98020 U.S.A.
Phone (206) 542-9223

June 30, 1983

Mr. Paul Schmeil
Kaiser Aluminum &
Chemical Corporation
3400 Taylor Way
Tacoma, WA 98421

Re: Sludge stabilization - progress report

Dear Mr. Schmeil:

This letter report is intended to serve as a progress report on the physical testing and preliminary evaluation for stabilization of waste sludge from the Tacoma plant.

Three large samples of sludge were provided by Landau Associates in May, 1983, each consisting of about 200 pounds of wet sludge. These were obtained from three different locations at the plant site. The testing to date has been in the laboratory of the Department of Civil engineering, University of Washington.

Initially, the approach used was to consider the sludge to be a soil that could be treated using additives in much the same way as in stabilization for construction purposes. The objective was to obtain a final material that (1) is improved structurally, i.e., stronger than natural soil and that could possibly be used for, say, a pavement base or a foundation material, or (2) is improved chemically and/or physically to reduce the possible escape of particles or reduce the tendency for leaching of components by surface or groundwater. Traditional stabilization additives would include:

(1) lime
(2) lime fly-ash
(3) portland cement
(4) asphalt
(5) combinations
(6) other chemicals

Treated soils would then be tested for suitability to meet criteria established by the U.S. Environmental Protection Agency and/or the Washington Department of Ecology. The intent of this phase is to develop materials and provide specimens for others to test.

Untreated Sludge

The first step was to characterize the sludge as it exists today. Several tests have been conducted and the results are shown in Table 1.

The specific gravity of the sludge (ASTM D-854) ranges from 2.73 to 2.87 and is similar to natural soil that consists of silt and clay. During the agitation phase of this test in a glass pycrometer, considerable dark gray to black material (probably organics) was dislodged and floated on top of the water.

The natural water content, as delivered to the laboratory, ranged from about 94 to 102 percent. These were based upon a thoroughly mixed sample (5-gallon container). However, it was noted that if the large sample were allowed to stand for a few hours, the solid particles settled and left nearly clear water remaining on top. If a sample of sludge were placed in a pan and allowed to drain, the resulting water content was about 70-80 percent after one or two days. Thus, much of the water from the pond samples can probably be removed by stockpiling.

An attempt was made to sieve the dried samples to determine the gradation (ASTM C 136). However, due to static charges on the particles, they tend to flocculate and "blind" the screens. Thus it appears that more than 90 percent passes the No. 200 sieve (.074mm). A sample was also tested using the hydrometer method (ASTM D 422) and these results are shown in Figure 1. Below the 200 sieve it appears that a range of particle sizes exist, down to about 0.001 mm.

Although the sludge has the appearance of a fine silt or clay, it does not exhibit any plasticity in the Atterberg Limits test (ASTM D 424). Both the plastic limit and liquid limit tests were attempted but were unsuccessful; the soil would not roll into a thread (PL) and it was not possible to form a groove in the LL cup.

Based upon the above tests and observations, it appears that this sludge could be classed as an OL soil based upon the Unified Soil Classification System (U.S. Corps of Engineers, Tech. Memorandum No.3-357, March 1953). It is organic and has low to zero plasticity, is only moderately strong and is friable when dry.

Compaction tests on the sludge were made to determine the moisture-density relationship. Two levels of compaction were used, standard AASHTO (ASTM D698) and Modified AASHTO (ASTM D1557) as well as a very low level of compaction energy for one sample. For this test, the loose samples of sludge were oven-dried, then water was added back to reach the appropriate level for each test. Although the specific gravity of particles is relatively high, the compacted density is not. The maximum density ranges from 81 to 87 lb. per cu.ft. while for a natural soil of similar gradation (say a clay) the maximum values would be about 110 or higher. The reason is probably related to surface charges as was noted in the sieve analysis. Further, with the very fine particles, the surface charges become relatively more important when attempts are made to pack them close together. When dry, the compacted samples are noticeably lightweight. Optimum water content was about 32 percent for all compaction energy levels.

As a measure for future stabilization treatments, the strength of the untreated soil was tested. Following the Modified AASHTO compaction (at optimum moisture) specimens were extruded and tested unconfined in a universal testing machine. Results are as follows:

Specimen	Strength (psi)	Average
1	27	30 psi
2	35	

In summary, the sludge is similar to a natural soil, but has some properties that are somewhat unique. The extreme fineness will make stabilization a challenge and unusual methods may need to be developed.

Treated Sludge

As indicated earlier, numerous trials of mixtures will be formulated. To date, several of these have been tried and are summarized in Table 2. Note that Mix Nos. 001 through 004D were made with oven-dried sludge. The remainder shown in Table 2 were made with sludge in its naturally wet state. It appears that a wide range of success is possible, but since curing is still underway and evaluation is incomplete, the results will be reported later. We will keep you informed as additional information becomes available.

Please let me know if you have questions or comments.

Very truly yours,

Ronald L. Terrel

Ronald L. Terrel

RLT:am

Table 1 - Summary of Physical Properties of Untreated Sludge

Property	Sample No. A	Sample No. B	Sample No. C
Unified soil classification (OL, organic silt, non plastic, dark gray, strong odor, low dry strength)	OL	OL	OL
Specific gravity	2.87	2.73	2.85
Atterberg limits (plasticity)	NP	NP	NP
Natural water content, % (as sampled)	100.8	101.9	93.8
Compaction characteristics (see Figs. 2,3,4) optimum water content,%	32	33	32
maximum dry density, pcf	87	81	81

Non plastic

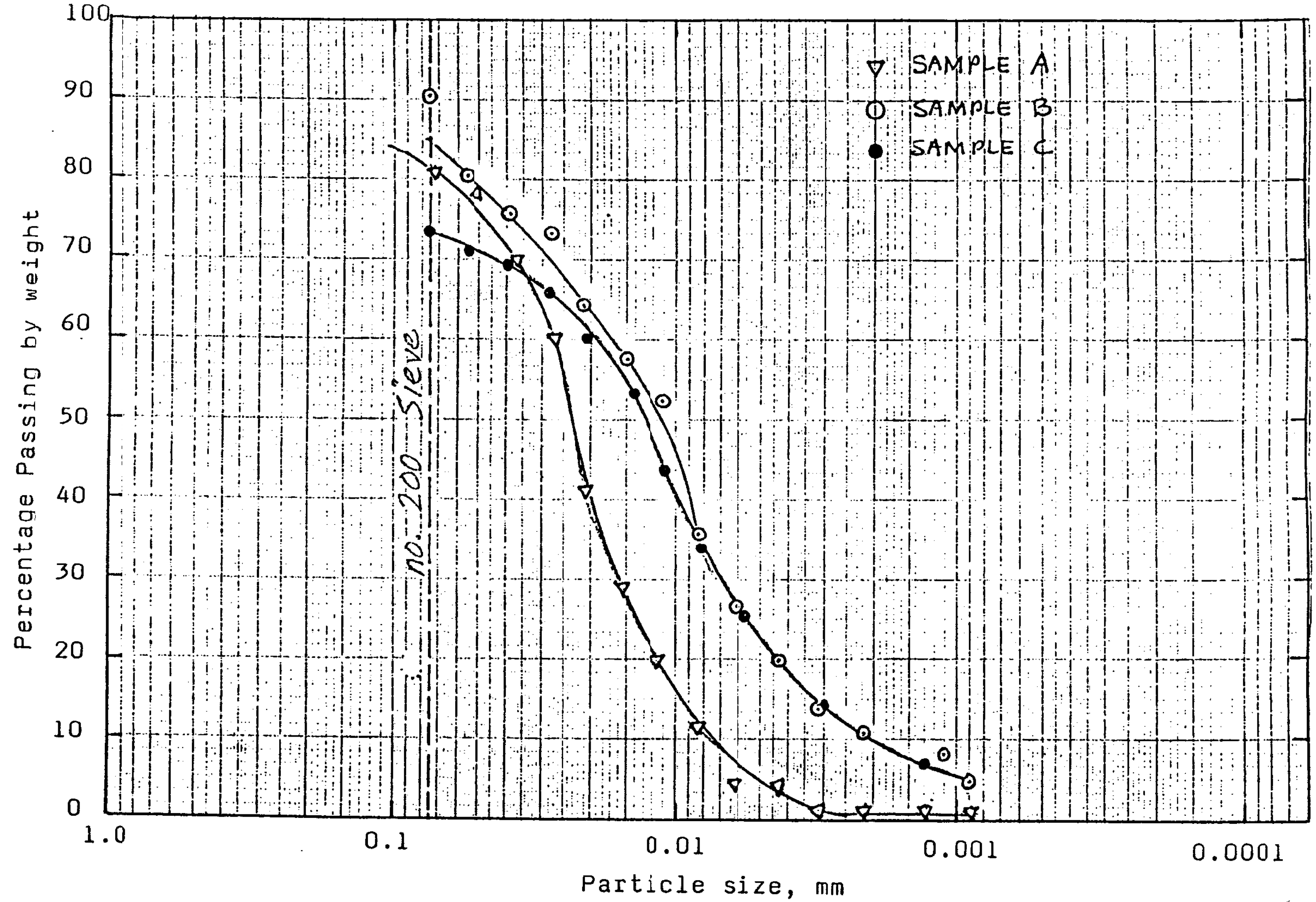


Figure 1 - Results of Hydrometer Analysis on Sludge Samples

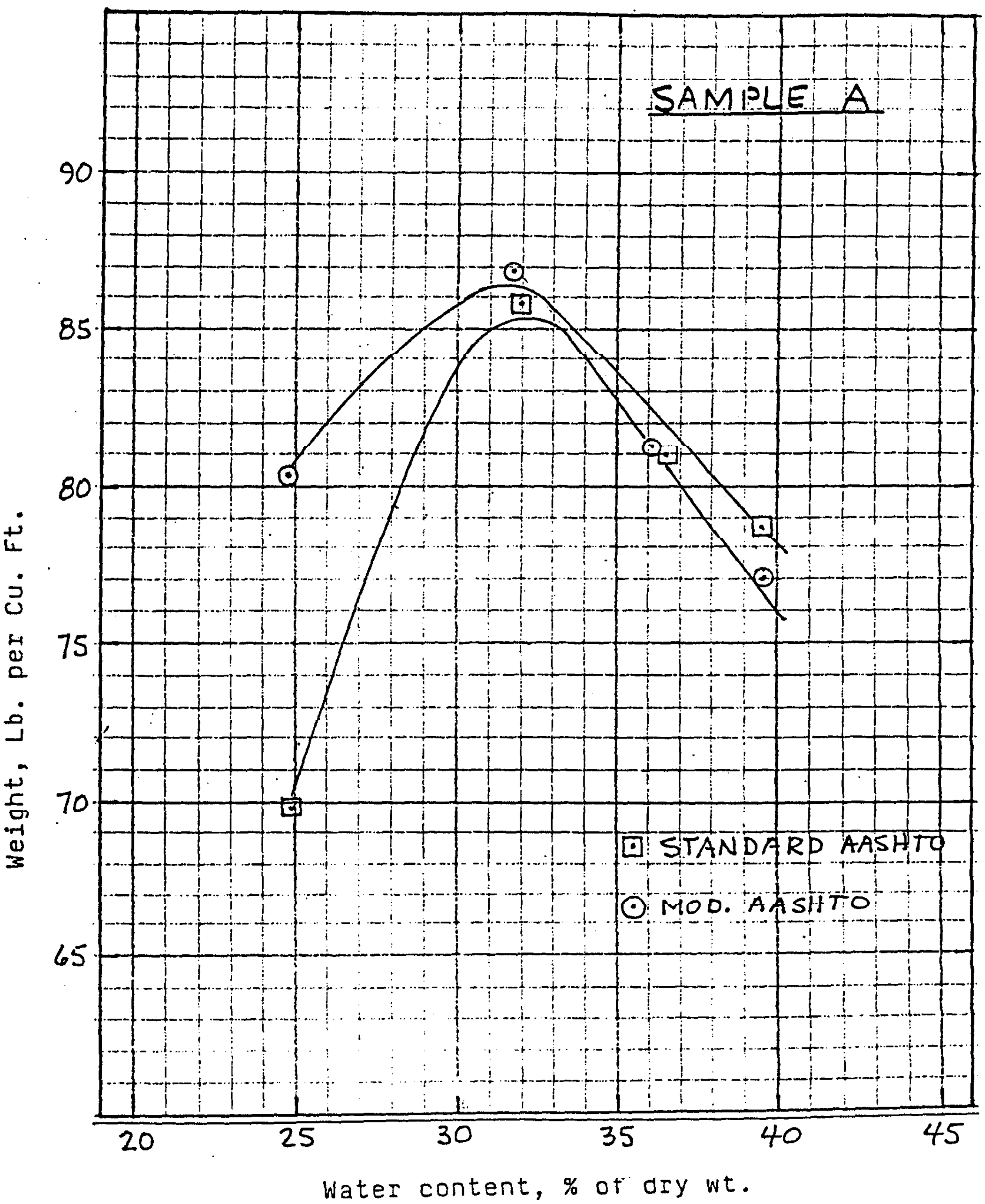


Figure 2 - Moisture-density relationship

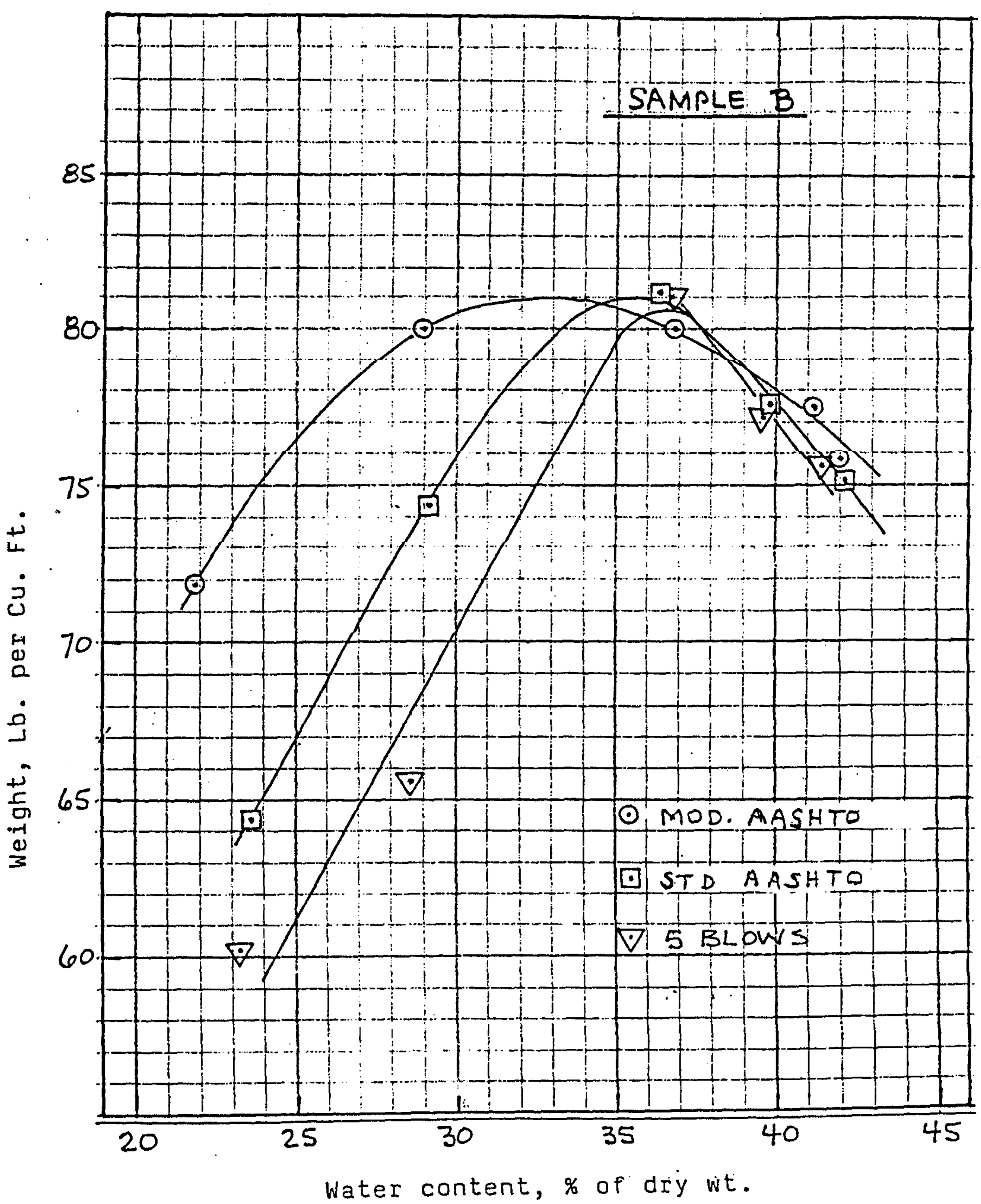


Figure 3 - Moisture-density relationship

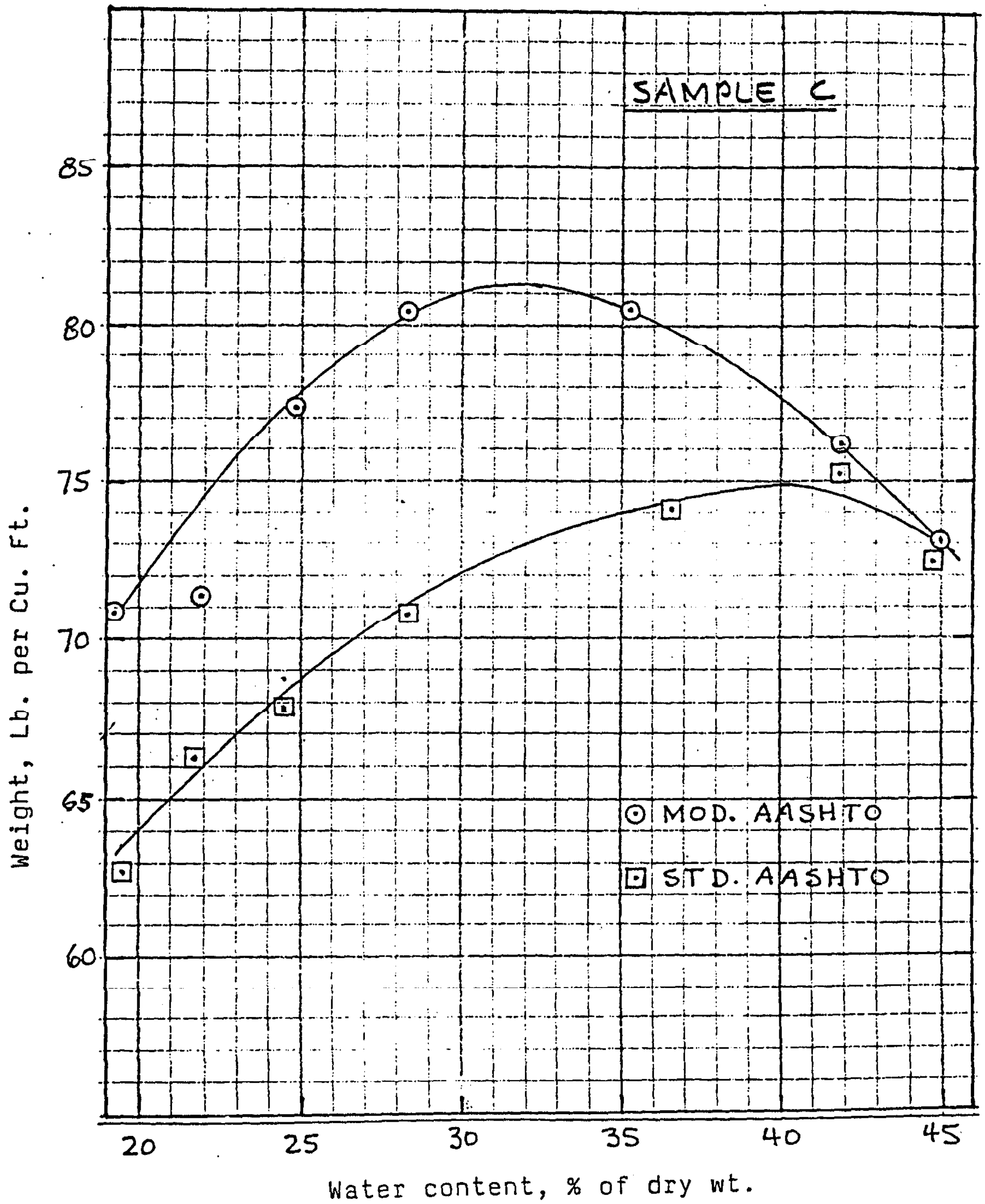


Figure 4 - Moisture-density relationship

Table 2 - Summary of Sludge Stabilization Mixture in Progress

MIX SUMMARY

Mix No.	Percentages Based on Dry Wt. of Soil										Remarks
	Sludge		Water Added	Lime		Fly Ash	Port. Cemt.	Asph. (Res)	Fine Agg.	Crse. Agg.	
	Dry	Wet		Ca (OH)2	CaO						
001	100		33								Optimum water content = 33%
002A	100		33	3							
002B	100		33	6							
002C	100		33	9							
003A	100		33					9			
003B	100		33					11			
003C	100		33					13			
004A	100		33				5				
004B	100		33				7				
004C	100		33				10				
004D	100		33				12				
005		186.4			18.6	9.3					Water content in the wet sludge was found to be 86.4%
006		186.4			9.3	18.6		5.58			
007A		186.4			18.6	9.3		5.58			Emulsion was added first to the sludge.
007B		186.4			18.6	9.3		5.58			Lime & FA were added first to the sludge

TERREL ASSOCIATES, INC.

Table 2 - Continued

MIX SUMMARY

Mix No.	Percentages Based on Dry Wt. of Soil										Remarks
	Sludge		Water Added	Lime		Fly Ash	Port. Cemt.	Asph. (Res)	Fine Agg.	Crse. Agg.	
	Dry	Wet		Ca (OH)2	CaO						
008		186.4					18.6	5.58			
009	100		50		20	10		6			
010	100		50		20	10					
011	1	180			25			30	155	200	Water Content of wet sludge = 80%
012A		180			25			45	140	200	Emulsion was added on the aggregate first
012B		180			25			45	140	200	Emulsion was added on the wet Sludge & Lime
013A		180			25			65	120	200	Emulsion was added on the aggregate first
013B		180			25			65	120	200	Emulsion was added on the wet sludge & Lime

TERREL ASSOCIATES, INC.

E.V.S. Consultants
Biological and Chemical Services
for the Environment

195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: (604) 986-4331
986-1516

Our File: 138-1

June 27, 1983

Mr. Paul Schmeil
Staff Environmental Engineer
Kaiser Aluminum and Chemical Corporation
3400 Taylor Way
Tacoma, Washington
98421

Dear Mr. Schmeil:

Re: Report on Toxicity of Sludge at the Kaiser Tacoma Plant

We have undertaken a series of extractions on the Kaiser pond sludge from the Tacoma plant to obtain information on the constituent materials that are water soluble and acutely toxic to fish. This information is important to the final selection of materials for contaminant stabilization and/or clean-up. Selective solvent fractionation of the sludge material, elemental and spectrophotometric analysis, and fish toxicity bioassays were undertaken to identify the group or class of compounds (i.e. phenolics or other organics) that may be responsible for acute toxic effects on fish. The initial tests of the sludge have been completed, and the results are summarized below and in Figure 1.

RESULTS

The initial analyses included an inductively coupled plasma (ICP) scan, qualitative spectrophotometry, and possibly gas chromotography on a selected sample. The results of these analyses indicated a number of potential toxic constituents, and eliminated a number of possible potential toxic constituents. Specifically:

1. Aluminum is present in the sludge at 8.49 ppm. Aluminum in the dissolved form is highly toxic, and at this concentration was the most significant metal present in the sludge. However, aluminum is probably not responsible for the acute toxicity observed in the sludge because at the levels of sludge that are toxic (50 mg/L) aluminum would be diluted to a concentration of .00042 mg/L, substantially below its acute lethal concentration. Acute lethal concentrations of aluminum range from 0.25 to 1.0 mg/L, depending upon pH values.

2. Cyanide was present as a trace constituent (0.01 mg/L). As with aluminum, such a concentration would not be toxic to fish exposed to 50 mg/L of sludge.

3. The initial analyses did not identify any other cationic constituents that would be present at concentrations of concern.

4. The foregoing observations are consistent with the results of the fractionation of the Kaiser pond sludge. Figure 1 shows the four fractions that were tested for toxicity, and the percentage of toxicity associated with each. These were:

Fraction	Percent of Toxicity
Kaiser Pond Sludge	100%
Acid fraction	0.4%
Base fraction	0.3%
Neutral fraction	66%
Residual sludge	33%

On the basis of these results, it is clear that the majority of the toxic constituents are located in the neutral fraction. Virtually no toxicity is associated with the acid or base fraction, which ruled out the possibility of phenolic compounds being responsible for some of the acute lethality. The residual sludge toxicity was inferred by difference rather than being the result of a 96-h LC50 test, and may require some further testing should the toxicity of that fraction be of concern. However, the fact that 66% of the toxicity could be extracted into the neutral fraction clearly indicates these are the constituents of concern for stabilization.

A review of recent literature (Konasewich et al., 1981) provides some indication of the relative toxicity of polynuclear aromatic compounds (PNA's) that may be present in the neutral fraction. Previous analyses have shown that PNA's are present in the Kaiser sludge at concentrations up to approximately 5% by weight. A 96-h LC50 of 50 mg/L of Kaiser pond sludge would contain up to 2.5 mg/L of PNA's. This concentration is consistent with the limited information that is available on the acute lethal toxicity of some PNA compounds, as shown in Table 1.

RECOMMENDATION

We recommend a GC/MS analysis of the neutral fraction to ascertain the specific constituents that may be responsible for the acute lethal toxicity. This is recommended for two reasons:

1. For sludge stabilization it is important to know whether toxicity is due to a small amount of a highly toxic constituent or a larger amount of a less toxic constituent. For example, halogenated naphthalenes are substantially more toxic than the parent compound. With fluorides present, the possibility of such compounds being present and toxic should be determined. The need for this analysis may become more apparent during the stabilization studies.

2. Very little is known about the acute lethality of polynuclear aromatics in general, other than that they vary considerably in the toxicity of individual compounds.

Such analyses may be accomodated within our existing budget.

TOXICITY METHODOLOGY

Static 96-h LC50's were used to determine the relative toxicity of the various fractions of Kaiser pond sludge. These data were consistent with the initial regulatory bioassay conducted by WDOE in as much as they observed mortality at 100 mg/L and 1000 mg/L. Our work showed that the pond sludge caused mortality in 50% of the rainbow trout test fish over a 96-h exposure period at a concentration of 50.7 mg/L, which defines the 96-h LC50. Various types of calculations were used to arrive at the 96-h LC50 and these calculations, together with the raw data for survival at all test concentrations is presented in Appendix 1.

We used the concept of toxic units, for purposes of calculating a toxicity balance a toxic unit being equivalent to the 96-h LC50 value. For ease of calculations we have rounded the 96-h LC50 of the Kaiser pond sludge to 50 mg/L (wet weight) and equated 50 mg to one toxic unit. From this value, we can extract 10 g of sludge, and calculate the mass balance on the basis that 10 grams contains 200 toxic units. Knowing the volume of the extract, the contribution to acute toxicity of each fraction, and the proportion of toxics associated with each fraction was calculated, and expressed as a percentage of the original acute lethal toxicity of the Kaiser pond sludge. This approach is advantageous because the reciprocal of the 96-h LC50 value (i.e the toxic unit), becomes a whole number that increases with increasing toxicity, enabling the calculation of the mass balance.

Additional details on extraction procedures, weights and volumes used, mixing times, and aliquots used for analysis and bioassay are available, and will be provided for our meetings on June 30, 1983.

Yours truly,

E.V.S. CONSULTANTS LTD.

Gary A. Vigers, Ph.D.,
President

GAV:mkm

cc: H. Landau

REFERENCES

EPA. 1978. Ambient Water Quality Criteria: Acenaphthene. NTIS. PB-296. 782.

EPA. 1978. Ambient Water Quality Criteria: Fluoranthene. NTIS. PB-292. 433.

EPA. 1978. Ambient Water Quality Criteria: Naphthalene. NTIS. PB-296. 786.

Conway, R.A. and B.C. Malloy. 1981. Hazardous Solid Waste Testing: First Conference. American Society for Testing and Materials, Special Technical Publication 760, 386 pp.

Konasewich, D.E., P.M. Chapman, E. Gerencher, G.A. Vigers and N. Treloar. 1982. Effects, Pathways, Processes and Transformation of Puget Sound Contaminants of Concern. NOAA Technical Memorandum OMPA-20, 357 pp.

Samoiloff, M.R., J. Bell, D.A. Birkholz, G.R.B. Webster, E.G. Arnott, R. Pulak and A. Madrid. 1983. Combined bioassay-chemical fractionation scheme for the determination and ranking of toxic chemicals in sediments. Environ. Sci. Technol. 17 (6): 329-334.

FIGURE 1

FRACTIONATION AND INITIAL EXTRACTION SCHEME
FOR TOXICS IN KAISER POND SLUDGE

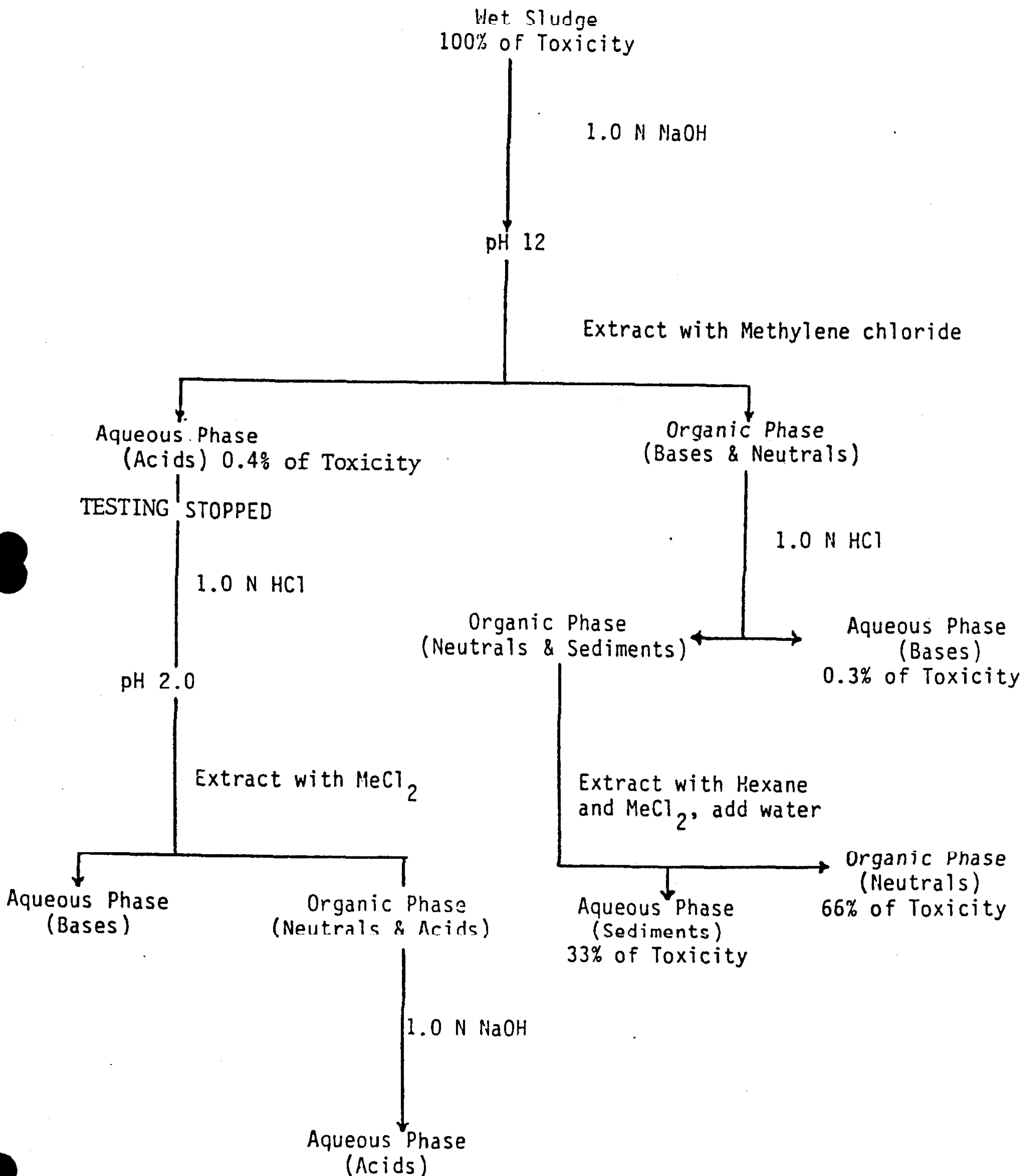


TABLE I

PNA TOXICITY DATA

Polyaromatic Hydrocarbon	FW/SW*	Test Species	Toxicity		
Acenaphthene	FW	Bluegill, *Lepomis macrochirus*	96-h LC50	1,700	ug/L
	FW	Cladoceran, *Daphnia magna*	48-h LC50	41,200	ug/L
	SW	Sheepshead minnow, *Cyprinodon variegatus*	96-h LC50	2,230	ug/L
	SW	Mysid shrimp, *Mysidopsis bahia*	96-h LC50	970	ug/L
Fluoranthene	FW	Bluegill, *Lepomis macrochirus*	96-h LC50	3,980	ug/L
	FW	Cladoceran, *Daphnia magna*	48-h LC50	325,000	ug/L
	SW	Sheepshead minnow, *Cyprinodon variegatus*	96-h LC50	560,000	ug/L
	SW	Mysid shrimp, *Mysidopsis bahia*	96-h LC50	40	ug/L
Naphthalene	FW	Mosquito fish, *Gambusia affinis*	96-h LC50	150,000	ug/L
	FW	Coho salmon, *Oncorynchus kisutch*	6-h LC50	5,600	ug/L
	FW	Cladoceran, *Daphnia magna*	48-h LC50	8,570	ug/L
	SW	Sheepshead minnow, *Cyprinodon variegatus*	24-h LC50	2,400	ug/L
	SW	Grass shrimp, *Palaemonetes pugio*	96-h LC50	2,350	ug/L

* FW = Freshwater
SW = Saltwater

TABLE 2

KAISER POND SLUDGE ELUTRIATE ANALYSIS

pH	6.25
Alkalinity (HCO_3)	23.0 mg/L
Conductivity	140.0 umhos/cm
Cyanide	0.010 mg/L
% moisture	40.53%

ASL

TABLE 3 MULTI-ELEMENT ANALYSIS

Parameter		Sample Identification			
		Kaiser Pond Sludge			
Scan 1					
Aluminum	Al	8.49			
Barium	Ba	0.001			
Calcium	Ca	9.48			
Iron	Fe	0.26			
Potassium	K	0.70			
Lithium	Li	L 0.05			
Magnesium	Mg	0.44			
Manganese	Mn	0.051			
Sodium	Na	26.7			
Phosphorus	P	L 0.10			
Silicon	Si	0.32			
Strontium	Sr	0.025			
Titanium	Ti	L 0.001			
Thallium	Tl	--			
Zirconium	Zr	L 0.005			
Scan 2					
Silver	Ag	L 0.002			
Arsenic	As	L 0.2			
Boron	B	L 0.01			
Beryllium	Be	L 0.001			
Bismuth	Bi	L 0.20			
Cadmium	Cd	L 0.007			
Cobalt	Co	L 0.01			
Chromium	Cr	L 0.002			
Copper	Cu	0.009			
Mercury	Hg	L 0.050			
Molybdenum	Mo	0.030			
Nickel	Ni	0.010			
Lead	Pb	L 0.050			
Antimony	Sb	L 0.05			
Selenium	Se	L 0.05			
Thorium	Th	L 0.10			
Uranium	U	L 0.30			
Vanadium	V	0.015			
Zinc	Zn	0.030			

All results expressed as mg/L

L = less than

All analysis by ICAP.

APPENDIX I

80N

KAISER POND SLUDGE

****

CONC.	# EXP /DOSE	# DEAD	% DEAD	BINOMIAL PROB.(%)
500	10	10	100	.09765625
100	10	9	90	1.07421875
56	10	6	60	37.6953125
32	10	2	20	5.46875
18	10	0	0	.09765625
10	10	0	0	.09765625

THE BINOMIAL TESTS SHOWS
THAT 18 AND 100 CAN BE
USED AS STATISTICALLY SOUND
CONSERVATIVE 95 PERCENT CONFIDENCE
LIMITS SINCE THE ACTUAL CONFIDENCE
LEVEL ASSOCIATED WITH THESE
LIMITS IS 98.828125 PERCENT.

AN APPROXIMATE LC50 FOR THIS SET OF
DATA IS 48.9561326

--------RESULTS CALCULATED USING THE MOVING AVERAGE METHOD

SPAN	G	LC50	95 PERCENT CONFIDENCE LIMITS	
3	.238430596	51.0141372	28.9950545	74.2385965

--------RESULTS CALCULATED USING THE PROBIT METHOD

ITERATIONS	G	H	GOODNESS OF FIT PROBABILITY
7	.247560474	1	.990405029

SLOPE = 4.736606
95 PERCENT CONFIDENCE LIMITS =2.37988821 AND 7.09333098

LC50 = 50.7110921
95 PERCENT CONFIDENCE LIMITS = 38.6256558 AND 68.3239858

****

80N

KAISER NEUTRALS
****

CONC.	# EXP /DOSE	# DEAD	% DEAD	BINOMIAL PROB.(%)
56	10	10	100	.09765625
32	10	10	100	.09765625
10	10	9	90	1.07421875
5.6	10	10	100	.09765625
1	10	5	50	62.3046875
.56	10	0	0	.09765625

THE BINOMIAL TESTS SHOWS THAT .56 AND 5.6 CAN BE USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT CONFIDENCE LIMITS SINCE THE ACTUAL CONFIDENCE LEVEL ASSOCIATED WITH THESE LIMITS IS 99.8046875 PERCENT.

AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 1

THE MOVING AVERAGE METHOD CANNOT BE USED WITH THIS SET OF DATA BECAUSE NO SPAN WHICH PRODUCES MOVING AVERAGE ANGLES THAT BRACKET 45 DEGREES ALSO USES TWO PERCENT DEAD BETWEEN 0 AND 100 PERCENT.

--------RESULTS CALCULATED USING THE PROBIT METHOD

ITERATIONS	G	H	GOODNESS OF FIT PROBABILITY
7	.214252432	1	.14644136

SLOPE = 2.47207802
95 PERCENT CONFIDENCE LIMITS =1.32781713 AND 3.61633891

LC50 = 1.52408609
95 PERCENT CONFIDENCE LIMITS = .886995532 AND 2.62478181
****

RWN

KAISER ACIDS

****

CONC.	# EXP /DOSE	# DEAD	% DEAD	BINOMIAL PROB.(%)
320	10	10	100	.09765625
180	10	0	0	.09765625
100	10	0	0	.09765625
75	10	0	0	.09765625
56	10	0	0	.09765625

THE BINOMIAL TESTS SHOWS
THAT 180 AND 320 CAN BE
USED AS STATISTICALLY SOUND
CONSERVATIVE 95 PERCENT CONFIDENCE
LIMITS SINCE THE ACTUAL CONFIDENCE
LEVEL ASSOCIATED WITH THESE
LIMITS IS 99.8046875 PERCENT.

AN APPROXIMATE LC50 FOR THIS SET OF
DATA IS 240.000002

WHEN THERE ARE LESS THAT TWO
CONCENTRATIONS AT WHICH THE PERCENT
DEAD IS BETWEEN 0 AND 100, NEITHER THE
MOVING AVERAGE NOR THE PROBIT METHOD
CAN GIVE ANY STATISTICALLY SOUND
RESULTS.

****

30N

KAISER BASES

****

CONC.	# EXP /DOSE	# DEAD	% DEAD	BINOMIAL PROB.(%)
320	10	6	60	37.6953125
180	10	0	0	.09765625
100	10	0	0	.09765625
75	10	0	0	.09765625
56	10	0	0	.09765625

THIS DATA SET DOES NOT MEET THE CRITERIA ESTABLISHED BY THE COMMITTEE ON METHODS FOR TOXICITY WITH AQUATIC ORGANISMS BECAUSE NO PERCENT DEAD IS GREATER THAN 65%.

THE BINOMIAL TEST SHOWS THAT 180 AND +INFINITY CAN BE USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT CONFIDENCE LIMITS SINCE THE ACTUAL CONFIDENCE LEVEL ASSOCIATED WITH THESE LIMITS IS 99.9023438 PERCENT.

AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 297.484676

WHEN THERE ARE LESS THAT TWO CONCENTRATIONS AT WHICH THE PERCENT DEAD IS BETWEEN 0 AND 100, NEITHER THE MOVING AVERAGE NOR THE PROBIT METHOD CAN GIVE ANY STATISTICALLY SOUND RESULTS.

****

KAISER ALUMINUM
& CHEMICAL CORPORATION

May 12, 1983

Mr. John F. Spencer
Deputy Director
Department of Ecology
Mail Stop: PV-11
Olympia, WA 98504

Dear Mr. Spencer,

As part of the site survey work for our Tacoma Plant Modernization, several sludge samples were collected during the geotechnical study of the site, analyzed and found to contain about 5% polynuclear aromatic hydrocarbons (PAH's). We have approximately 60,000 cubic yards of sludge which was produced prior to mid-1974 by our wet scrubber systems.

On April 15, 1983, we received DOE Order No. DE-83-197 "in the matter of DETERMINING SLUDGE EFFECTS ON WATER QUALITY by the Kaiser Aluminum & Chemical Corporation, Tacoma Works." We are in the process of carrying out this order. However, we request your decision on which regulations, if any, will apply in this case.

The sludge would fall under the Washington State EHW classification by virtue of exceeding 1% PAH as well as failing a fish bioassay test. This waste, however, was produced prior to RCRA and the ensuing Washington State hazardous waste law. The waste is not classified as hazardous under the RCRA EP toxicity criteria. It is our understanding that DOE is citing the water quality laws in support for their issuance of the regulatory order mentioned above. As you can see, we are faced with considerable confusion as to which, if any, regulations apply. We are concerned that our efforts to mitigate the effects of the sludge may place us under a new set of regulations which could overly restrict our opportunity to deal with problem.

The possible options available to Kaiser for dealing with the sludge include:

1. Solidification and beneficial use as paving or fill. This alternative appears to be the most desirable in carrying out our modernization project.

2. Leave in place and do not disturb. This alternative would be desirable in the event that modernization plans are abandoned or postponed for a period of time.

300 LAKESIDE DRIVE OAKLAND CALIFORNIA 94643

3. Removal of the sludge. This alternative could be very expensive, especially if the waste had to go to a hazardous waste site.

4. Treat the sludge, if possible, so as to reclaim any useful chemicals and detoxify or remove the remainder.

The above four alternatives represent the range of possibilities for dealing with the problem. Your prompt reply to our request will allow exploration of the allowable alternatives.

Should you have any questions, please feel free to contact Paul Schmeil at (206)593-0716, John Baker at (206)593-0701, or Ron Schutz at (206)593-0728.

Sincerely,

KAISER ALUMINUM & CHEMICAL CORPORATION

J E Sparkman

J. E. Sparkman
Vice President & General Manager
Primary Products Division

cc: J. V. Day - KB 1445
J. T. Baker KACC Tacoma
P. F. Schmeil " "
R. C. Schutz " "
N. Prakash " "
H. Landau Landau & Associates

June 6, 1983

Mr. John Spencer
Deputy Director
Washington State
Department of Ecology
Mail Stop: PV-11
Olympia, WA 98504

Dear Mr. Spencer:

I wish to thank you and your staff for the excellent meeting on Friday, May 27, 1983. Considering the present limited availability of information on the Kaiser wet scrubber sludge disposal site, the guidance obtained at that meeting seems entirely adequate for present planning activities by Kaiser.

We were initially concerned that corrective action, using the best and most economic technology, could trigger more restrictive regulations. Out meeting with you and your staff has minimized our concern. As handling options are developed, we will pass them to your staff for review. We will, undoubtedly, need future guidance on acceptability of any options.

We intend to continue working closely with your staff until this problem is resolved. Completion of Phase I of our study of the site is anticipated by the end of June. An update will be presented to the DOE at that time.

Sincerely,

KAISER ALUMINUM & CHEMICAL CORPORATION

J. T. Baker
Technical Superintendent

JTB/jf

BCC: Paul Schmeil

AN EVALUATION OF SOLID WASTES FROM THE EASTALCO ALUMINUM COMPANY

MAY 1983

Prepared by:

STATE OF MARYLAND

Department of Health and
Mental Hygiene

Office of Environmental Programs

Waste Management Administration

Mr. Ronald Nelson, Director

Executive Summary

Eastalco Aluminum Company, a primary aluminum smelting company located in Frederick County, Maryland has proposed to construct a landfill on plant property to contain certain solid wastes which are generated as part of plant operations. These wastes include potliner brick, cryolite pond mud, fluoridated alumina, pitch sludge, wet scrubber mud, mist eliminators, bag house waste and floor sweepings. These wastes have been tested by the NUS Corporation using the test protocol established by the federal Environmental Protection Agency and the Department to determine if a waste is hazardous under the provisions of federal and State Law. The test, the Extraction Procedure or EP Toxicity Test, indicates that the wastes are not hazardous under current standards.

The Department collected samples of the brick material for additional testing. Specifically, tests were performed to determine the quantity of cyanide that may be leached from the material or may be released to the atmosphere; the potential for hydrogen sulfide release was evaluated; and the amount of leachable fluoride was determined. On the basis of these tests, the Department has concluded that the brick material presently contained on the storage pads may be safely landfilled on the site without creating an undue risk to public health or the environment. The Department plans additional studies of fresh brick material to determine how the material should be handled after extraction from the pots and prior to landfilling on the site.

The proposed landfill is to be located on plant property 300 ft. southwest of the cryolite plant. The landfill will encompass 2½ acres, and will be constructed by excavating to a depth of 8.5 feet. A 30 mil pvc liner will be placed over a prepared subbase and then covered with 1.5 feet of compacted clean earth which will protect the liner material. The cell floor will be sloped to a collection sump. All collected leachate will be pumped from the landfill to be used as make-up water in the wet scrubber system on the pot rooms. If make-up water is not needed, the wastewater will be diverted to the fluoride precipitation system for treatment prior to discharge via the outfall to the Potomac River. At present waste generation rates, the landfill will last about 9½ years. After closure, a 30 mil pvc cap will be installed over the landfill to further retard infiltration. At least two feet of soil will be placed over the cap and the area will then vegetatively stabilized. A groundwater monitoring system will be installed around the landfill and will be used to collect groundwater samples under the landfill during its active life and after closure of the fill.

The site is located in the Frederick Valley Region geologic province. The rock formation underneath the site belongs to the Frederick Formation, which is a thin-bedded limestone with clayey layers and shaley zones. Surficial soils belong to the Duffield Series, which consist of clayey silts, silts and clays with minor amounts of sand and rock fragments. Soil thickness over bedrock varies from 22.5 feet to 35.3 feet. Soil permeabilities range from between 4.1×10^{-5} cm/sec to 1.9×10^{-6} cm/sec. Well pump tests performed at the site in 1974 indicate that the soils act as an essentially impervious confining layer over the limestone aquifer. Hence, the presence of the landfill does not pose a risk to water quality in the deeper limestone aquifer.

On the basis of the available information on waste characteristics, landfill design and operational constraints, and site geology, the Department proposes to allow construction and operation of the landfill to accommodate the waste potliner brick presently stored on site. From data which has been submitted by the company and from a review of EPA literature, it appears that the other specified waste materials could also be safely landfilled. The Department has collected samples of these materials, the cryolite pond mud, fluoridated alumina, wet scrubber mud and pitch sludge. Analytical tests are now being performed by State personnel. If these results support the analyses previously submitted, the Department proposes to modify the permit to allow inclusion of the additional wastes.

Na_2SO_4	0.71%
Al_2O_3	75.7%
F^-	7.3%
Na	4.7%
Cryolite	13.7%

An analysis of the material using the EP Toxicity procedure yielded the following results:

Arsenic	0.035 mg/l
Barium	0.1 mg/l
Cadmium	0.012 mg/l
Chromium ($^{+6}$)	<0.01 mg/l
Chromium (Total)	<0.01 mg/l
Lead	<0.03 mg/l
Mercury	<0.0002 mg/l
Selenium	0.011 mg/l
Silver	<0.01 mg/l

The material, when removed from the recycle tanks, is stockpiled in the scrubber aisles on steel plates for drying to an consistency suitable for handling by front end loader. Drainage is collected and recycled.

PITCH SLUDGE

Anodes utilized in the aluminum reduction plant are produced in the carbon plant utilizing a mixture of 84% petroleum coke and 16% coal tar pitch. The pitch is utilized as a binder. The mix is produced in a semicontinous process utilizing two mixers in series. Temperatures in the mixers range from 340°F to 280°F. The mixers and the discharge conveyor are exhausted to two wet scrubbers where the volatilized polycyclic hydrocarbons and some of the coke fines are collected. The collected solids in the scrubber water are discharged to a settling pond. This material makes up a portion of the pitch sludge. The discharged mixer material termed "paste" is fed to a 2750 ton capacity hydraulic press where green anode blocks weighing 565 lbs are produced. The pressed anodes discharge from the press at 200°F and are still too hot to handle. Thus, the conveyor passes the hot anodes through a spray water cooling unit. The collected spray water contains small amounts of petroleum coke and coal tar pitch which dislodged from the green anode blocks during the spraying process. This water is also discharged to the settling pond and makes up the remainder of the pitch sludge which is continuously raked from the pond.

It is estimated that 260 tons of pitch sludge waste per year is produced. The petroleum coke collected is essentially pure carbon. Coal tar pitch is very complex and is known to contain thousands of polycyclic hydrocarbons as well as inert carbon. Only about 300 of the polycyclic hydrocarbons have been identified. The polycyclic hydrocarbons captured in the wet scrubbers would be typically of the 2 or 3 ring type that would volatilize at the low mixture temperatures encountered. Organics are released in greater quantities at the elevated temperatures encountered in the anode baking operation, and could therefore be expected in any effluent from this operation. In reviewing this industry to develop effluent guidelines, EPA collected samples of the bake house wet scrubber wastewater. Although these analyses are not of the sludge itself, they would be indicative of the pollutants which may be present in the sludge. EPA reported the results of these analyses as follows:

Acenaphthene	20.5 mg/l
2-Chloronaphthalene	0.041 mg/l
Fluoranthene	5.0 mg/l
bis(2-Chloroisopropyl)ether	0.013 mg/l
napthalene	3.3 mg/l
N-nitrosodiphenylamine	0.019 mg/l
bis(2-ethylhexyl)phthalate	0.841 mg/l
di-n-butyl phthalate	0.011 mg/l
benzo(a)anthracene	1.07 mg/l
benzo(a)pyrene	0.24 mg/l
chrysene	1.4 mg/l
acenaphthylene	0.018 mg/l
fluorene	3.0 mg/l
pyrene	4.1 mg/l
arsenic	0.008 mg/l
chromuim	0.008 mg/l
copper	0.024 mg/l
cyanide	0.031 mg/l
lead	0.179 mg/l
mercury	0.0001 mg/l
nickel	0.008 mg/l
silver	<0.001 mg/l
zinc	0.007 mg/l
ammonia	2.8 mg/l
COD	177 mg/l
Fluoride	0.4 mg/l
phenols	1.7 mg/l
TOC	29 mg/l
Oil & Grease	25 mg/l
TSS	705 mg/l

This plant, however, uses a dry scrubber system in the bakehouse, which incorporates adsorption on activated alumina. This material is then recylced to the pots, thus not directly contributing to the waste streams, unless it becomes contaminated by spillage during removal from the scrubbing system. If it becomes contaminated, it will be landfilled. The subject of organics in the Eastalco wastes was considered in a file memorandum prepared by Mr. Edward Gertler, a project engineer with the Department. The memorandum and references are attached. On the basis of this information, it is concluded that the presence of organics does not pose a threat to groundwater resources.

MISCELLANEOUS WASTES

Miscellaneous wastes include mist eliminators and plant floor sweepings. Mist eliminators are Z-shaped plastic baffles used to intercept mist from the wet scrubbers. The pieces eventually become fouled with sulfate scale and entrained fluorides and are discarded. The mist eliminators last from 2 to 4 years before needing replacement. They are constructed of NORYL ENG-265-701, a temperature resistant plastic. The company generates about 5 tons of this material per year.

Most floor sweeping are returned to the pot. Occasionally, however, some floor sweepings, which are typically fluoridated alumina, are contaminated with soil and must be landfilled. The estimated quantity of this waste is 5 tons per year.

STATE OF MARYLAND — DEPARTMENT OF HEALTH AND MENTAL HYGIENE

MEMORANDUM

Copies

TO File 80-DP-0137 From Edward Gertler Date 5/2/83

Subject Organics in Eastalco Wastes

I conferred with Jim Berlow, engineer with EPA's Effluent Guidelines Division and Dr. Murry Strier, EPA chemist, to clarify some points regarding organics in aluminum plant wastewater and solid wastes. The organics are referred to as PAHs, short for polynuclear aromatic hydrocarbons. The new draft development document lists the following PAHs as present in both detectable and technologically reduceable concentrations: acenaphthene, fluoranthene, benzo(a)pyrene, chrysene, acenaphthylene, anthracene, benzo(ghi)perylene, fluorene, phenanthrene, dibenzo(a,h)anthracene and pyrene. Benzo(a)pyrene was selected as an indicator compound, being one of the more hazardous of the group. In general, all of these compounds are byproducts of incomplete combustion or heating of organic substances. All or most of these products are present in cigarette smoke, wood smoke, fossil fuel power plant emissions, automobile exhaust, and as a byproduct of plant biosynthesis. Benzo(a)pyrene is generated in the charcoal broiling of meat.

PAHs are generated by Eastalco as follows: In the paste plant as the raw anode materialis calcined; in the bakehouse as the pitch/coke is baked into anodes, the PAHs volatize off and in the contact cooling of anodes after ~~baking~~. The bulk of the PAHs are thus in the bakehouse fumes which are dry-scrubbed by baghouse and activated alumina. The contaminated alumina goes to the pots where the PAH becomes airborne again either volatized or adsorbed on escaping particulates. Those emissions directly from the pot are recycled, those entering the potroom are scrubbed in the wet system and thus enter the wastewater. PAHs are not generated in the pots as is the case with a Soderberg system. Finally, PAHs are present in the paste plant decant pond which receives scrubber water from the paste plant and contact anode cooling water.

PAHs possess very low solubility in water (see attached table) and adsorb strongly to suspended solids. They will be present on Eastalco's wastewater suspended solids and resultant wastewater treatment sludges. It was Dr. Streir's opinion that water leaching through such sludges in a landfill would not dissolve away the PAHs and only by physically dislodging the particulates would this matter re-enter the aquatic environment.

The technology for PAH removal is settling and filtration for the adsorbed materials and oxidation, activated carbon or biodegradation for the dissolved fraction. Those of simple structure biodegrade easily. A paper titled, "Fate of Toxic Organic Compounds in Wastewater Treatment Plants" reported removals in excess of 95% in conventional activated sludge plants--mainly as a result of solids removal. Some further treatability levels are listed below. Concerning those PAHs entering the Potomac River via 001, the concentrations would have to be very dilute (BaP in potroom scrubber effluent was only .04 mg/l in EPA DEV. DOC. monitoring data). Ambient Waste Qaualty Criteria for Polynuclear Aromatic Hydrocarbons stated that PAHs dissolved in the water column "will probably undergo direct photolysis at a rapid rate." It also states that PAH accumulated in the sediments is believed to undergo biodegradation and biotransformation by benthic organisims. Hence, we are probably not impacting downstream water intakes.

This general class of pollutants is considered a suspected carcinogen. Nobody has agreed on a theshold limit. The Handbook of Toxic and Hazardous Chemicals reports a 1970 WHO recommendation that PAH conentration not exceed .02 mg/l. They also reported an additional lifetime cancer risk of 1 in 100,000 posed by a concentration of .028 mg/l. The only other PAHs individually described were acenapthene with a recommended 20 mg/l and fluoranthene with 42 mg/l.

Treatability/Removability

Constituent	Treatment	Removal Range %	Avg. Achievable Con. mg/l
benz(a)anthracene	Sedimentation (lime & polymer)	81	<10
	gran. act. carbon	93-97	< .02
	Sedimentation (lime)	92	< 10
	Activated sludge	41	2950
benzo(a)pyrene	sedimentation	70-98	< 5.3
	Ozone oxidation	90	< .02
	Powdered act. carbon	87	6200
Chrysene	Sedimentation (lime & polymer)	99	10
	Sedimentation (lime)	92	< 10
	Activated sludge	65	1750
Fluoranthene	Filtration	29-50	.11
	Sedimentation	17-64	< 17
	Sedimentation (polymer & lime)	97	< 10
	Ozone	50	0.1
	Activated sludge	100	< 50
	gran. act. carbon	82-90	< .02
	Powder act. carbon	99	0.5

References

1. Hazardous Waste Management Seminar, Malcolm Pirnie, Inc., Lecture Notes

2. Ambient Water Quality Criteria for Polynuclear Aromatic Hydrocarbons, USEPA, October 1980.

3. Preliminary Assessment of the Sources, Control and Population Exposure to Airborne Polycyclic Organic Matter as Indicated by Benzo(A)Pyrene, Draft No. 1, May 1978.

4. Handbook of Toxic and Hazardous Chemicals by Marshall Sittig, 1981

5. Fate of Toxic Organic Compounds in Wastewater Treatment Plants, December 1981.

6. Personal Communication with Jim Berlow and Murry Streir of EPA.

Also personal communication with Mr. Ray Paterson, Oregon Dept. of Environmental Quality (503-229-5325)
- he stated that they are not presently regulating PAHs